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Transitional landscapes: Examining landscape fragmentation within peri-urban green spaces and its impacts upon human wellbeing

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Declaration of Originality

I hereby declare that I have personally carried out the entire work described in this thesis and is my own original work and that it has not been submitted in whole or in part for any other degree or professional qualification. Due references have been provided on all supporting literatures and resources.

Richard John le Brasseur

9 June 2018

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Abstract

Transitional land uses produced through urbanisation continue to change the landscape and fragment ecological structures including green spaces across Europe (Nilsson et al., 2013). Green spaces offer significant benefits to humans, contributing to wellbeing and life satisfaction (Taylor, 2002). The understanding of how these unique green spaces spaces function and provide benefits to humans, and how landscape change in peri-urban contexts affects their performance, is important.

The scope of this research is to contribute to an understanding of landscape fragmentation within some of Europe's polycentric urban regions, their peri-urban green spaces, and the associated impacts upon human quality of life. Two urban regional case studies, Paisley near Glasgow, Scotland, and Vantaa, near Helsinki, Finland were analysed and compared.

The results indicate that humans interacting with more physically or ecologically fragmented peri-urban green spaces have higher self-reported life satisfaction levels. Though no statistically significant characteristics were apparent between life satisfaction and fragmented green space characteristics, this research was able to identify those specific structural attributes and physical characteristics of interstitial peri-urban green spaces within a polycentric region in a fragmented state that contribute to the physical, social, and psychological aspects of human wellbeing. The statistically significant eco-spatial characteristics of polycentric peri-urban interstitial green spaces that are reported to impact human wellbeing are the size, proximity, maintenance and management, and the level of greenness within its vegetation composition and setting.

Overall, a spatially diverse, fragmented, peri-urban landscape whose green spaces are extensively sized, naturalistically shaped with horizontal vegetation and normal sized edges, most often parks or woodlands or forests which are integrated and physically connected to another green space which is moderately clean and somewhat safe as well as being located close to or adjacent to a heavy-trafficked road provide the most human wellbeing benefits.

Lay Summary

As landscapes change due to the development associated with human growth and progress, the many green spaces, forests, parks and reserves, and other open spaces are affected. Many of these impacts are negative and associated through landscape fragmentation and include a loss of ecological quality such as providing clean water, wildlife habitat and other associated benefits to humans through biodiversity and ecosystem services.

Unique to Europe's urbanisation process and growth patterns such as polycentric development, the peri-urban green spaces of cities are undergoing rapid change in land use and spatial configuration. This study analysed those impacts to green spaces and green structures within urbanising areas of Helsinki, Finland and Glasgow, Scotland and how these spatial impacts affected human quality of life specific to physical, social and psychological wellbeing.

Results showed that, unlike the reduction to ecological quality, landscape fragmentation within peri-urban green spaces did not necessarily reduce quality of life. This study supports that the fragmentation of peri-urban green spaces in the regions of study provided specific benefits to humans not found in other green space configurations such of large nature preserves or urban cities. Specifically, both social wellbeing (e.g. socialising with friends and community integration) and physical wellbeing (e.g. exercise and outdoor activities) were reported to be related to specific peri-urban green space physical and spatial qualities within a fragmented state, whereas psychological wellbeing benefits such as relaxing in nature and recharging were not.

This research concludes that as urbanisation continues in Europe, proper planning, management and design of the green spaces must ensure that the continued benefits are provided to residents.

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List of Acronyms

CA	Case Study Area
EEA	European Environment Agency
EFA	Exploratory Factor Analysis
ES	Ecosystem Services
ESDP	European Spatial Development Perspective
EU	European Union
FA	Factor Analysis
FGS	Favourite Green Space
FUA	Functional Urban Area
GIS	Geographic Information Systems
HWB	Human Wellbeing
IntGS	Interstitial green spaces
LS	Life Satisfaction
MSA	Metropolitan Statistical Area
OGS	Other Green Space
OS	Open Space
PIA	Polycentric Integrated Areas
PCA	Principal Component Analysis
PLUREL	Peri-urban Land Use Relationships
PolyPUR	Polycentric Peri-urban region
PolyUR	Polycentric Urban region
PPGIS	Public Participation Geographic Information System
PPUIGS	Polycentric Peri-urban Interstitial Green Space(s)
PUA	Peri-urban Area
PUL	Peri-urban Landscape
PUR	Peri-urban Region
PUGS	Peri Urban Green Space
PUIGS	Peri-urban Interstitial Green Space(s)
PUSH	Potential Urban Strategic Horizons
QOL	Quality of Life
SQ	Survey Questionnaire
SPSS	Statistical Package for the Social Sciences

UGS	Urban Green Space
UK	United Kingdom
US EPA	United States Environmental Protection Agency
UMZ	Urban Morphological Zone

The following GS Land Cover acronyms were utilised in Chapter 8:

Shrub and/or Herbaceous Vegetation (SHV);

Forests (F);

Open Space (OS);

Permanent Crops (PC);

Arable Land (AL);

Pastures and Grasslands (PAG);

Heterogeneous Agriculture Areas (HAG);

Shrub and/or Herbaceous Vegetation (SHV).

Chapter 1 - Introduction

1.1 Human Development Patterns and their Impact upon the Landscape

Human development is increasing across the globe (UNEP, 2007). In 2012, over half of the world's population lived in urbanised areas, with this figure expected to increase to 75% by 2050 (UN, 2012). Already, in Europe, approximately 80% of the population reside in urban areas (Haase, 2014)

Although most parts of the world, especially in developing countries, will see significant urbanisation in larger metropolitan conurbations and emerging megacities (Florida, 2008) Europe will continue to accommodate human development predominantly through polycentric urbanisation within its metropolitan regions (EC, 2011), a development arrangement that redistributes Europe's traditionally compact city forms (Herrschel, 2010).

Polycentric urban development, the preferred approach to spatial urbanisation in Europe, generates a more evenly distributed population across many smaller, connected, compact centres (de Geyter, 2002; Wandl, 2012). This practice is, however, often characterised by 'decentralised sprawl' (Ewing, 1997) and 'diffused' development patterns (Botequilha-Leitão, 2012) which result in a series of undeveloped spaces between these new urbanisations – interstitial green structures. Furthermore, this dispersed polycentric suburbanisation process of reoriented land use through human development results in significant landscape change (e.g. Vitousek, 1997; Antrop, 2004), notably landscape fragmentation within the peri-urban areas at the edges of urban development. Landscape fragmentation is a term describing the process by which urbanisation results in the division of large, continuous, landscape types, into smaller spaces with a lower total area that are more isolated from each other by a matrix of dissimilar landscape types.

Landscape fragmentation is also reflected in green infrastructural networks and green spaces, in which rural, agrarian, and other naturalistic land uses in the peri-urban region are replaced by more urban land use activities, creating many

smaller, less connected, and more urban green structures.

The fragmentation of peri-urban landscapes and their interstitial green structures occurs in a gradual manner and its effects are still being studied and acknowledged (EEA, 2011; EC, 2010b; ESDP, 1999) including both ecological (e.g. ecological integrity in Forman, 1995) and socio-economic impacts, such as on human welfare and wellbeing (MEA, 2000). The European Union has shown an awareness of the need for a better understanding of landscape fragmentation (MEA, 2005; EC, 2010, 2011; EEA, 2011) as increasing requirements arising from human development are placed upon its green structures and green spaces.

The continuous growth in the number and size of urban areas will continue, particularly, in Europe, through polycentric development patterns within peri-urban areas. The attendant fragmentation of the interstitial peri-urban green spaces may have significant consequences for the landscape's ability to provide human wellbeing benefits, and the role of green space under urbanising conditions is therefore worthy of further study.

1.1.1 Green Space and Human Wellbeing

A wealth of literature across multiple disciplines analyses and discusses the influences of the biological landscape and its green spaces and their associated benefits to humans (e.g. Jongman, 2002; Saunders et al., 1991; Taylor, 2000; and Bogaert et al., 2005) such as air quality, water infiltration and carbon offset, among others. Research encompassing social benefits such as quality of life, wellbeing, and human welfare, particularly beyond public health spheres, is limited, especially as related to spatial planning within policy decisions. In particular, although the literature illustrates the many benefits which green spaces supply humans (e.g. Kaplan, 1989; Korpela, 2001; Tzoulas et al., 2004; Chiesura, 2004; Ward Thompson et al., 2012) there is a lack of clarity as to the *exact* wellbeing benefits that interstitial green spaces provide in a fragmented landscape, and the *specific and unique* eco-spatial characteristics of these interstitial green structures that furnish these benefits. Answering these questions is critical in the face of continued urbanisation.

Discussing the weak relationship between research and landscape architecture and design Bell (2004, p. 3) notes: "*Designers have been more concerned with creating attractive settings for people to live, work and play. Their work has been practical, pragmatic and not always as deeply rooted as it might be in the theoretical and empirical work of the academic researcher in philosophy or psychology, although this is now changing*".

The landscape fragmentation unique to urbanising peri-urban regions directly and indirectly affects both ecological systems (i.e. ecosystems) and human functioning. The influences of such fragmentation upon the ecosystem and associated effects to humans are recognised primarily through negative impacts such as reduced air and water quality, reduced biodiversity, and decreased ecosysterm functioning. Europe's polycentric, peri-urban landscapes are a dynamic and contentious zone where traditional land uses such as agriculture, farming, forestry and other green spaces meet infrastructural expansion and urban development. The interests and pressures placed on these modified landscapes often create conflicts among stakeholders and land uses. For example, landscape fragmentation physically separates once contiguous green spaces, reducing their overall size and connectivity, thus lessening not only views of these green spaces but opportunities for interaction in which to achieve important human welfare such as physical, social and psychological wellbeing benefits.

1.2 Research Aim and Objective

Spatial planning and design practices must evolve and adapt to support an integrated approach towards green spaces within these urbanising landscapes that aims to solve the complex sociological and ecological concerns resulting from their constant economic and socio-cultural pressures.

This thesis does not address the ecological or biophysical consequences of urbanisation and landscape fragmentation; literature is well versed in that regards, but instead focusses, spatially, on fragmentation specific to peri-urban green spaces and the associated impacts to human wellbeing. By concentrating on the connectivity and fragmentation of European interstitial green structures and green spaces under the pressure of urbanisation, the goal of this research is to identify,

assess, analyse and express new theory and ideas about the dynamic eco-spatial relationships between interstitial green structures and human wellbeing and thus to contribute to the evolving study of the relationship between nature and humans.

This research aims to investigate the direct and indirect impacts arising from the processes of urbanisation and landscape fragmentation in emerging polycentric peri-urban regions in order to increase the capacity to make decisions that support human wellbeing and quality of life while not compromising their biological functioning. The research objective is to relate the characteristics of fragmentation – its landscape structure, patterns and form – within Europe's emerging polycentric peri-urban areas and their green spcaces and green structures to human wellbeing benefits in order to gain a better understanding of both the human and the spatial factors that affect this relationship.

1.3 Research Hypothesis

There is an assumption in the literature that since the fragmentation of landscapes and green spaces / green structures has a negative effect on ecological functioning and resources (Meeus and Gulinck, 2008; PLUREL, 2013) this is also the same for human functioning and wellbeing. To test this assumption, the hypothesis of this research is that the emergent polycentric regions in Eurpoe and their associated peri-urban areas develop and function as a series of interrelated processes producing a unique diffused pattern of development characterised by landscape fragmentation and the creation of interstitial green spaces that result in a loss of physical connectivity and ecosystem functionality and a reduction of ecosystem services (MEA, 2005; See Section 3.3.2), specifically human wellbeing benefits. Formalising this:

Hypothesis: The fragmentation of green spaces and green structures found within polycentric peri-urban regions of Europe negatively affects the production of wellbeing benefits to humans.

Result: Support or Deny

1.4 Research Questions

The primary research question is:

What are the *specific and unique* spatial attributes and physical characteristics of fragmented green structures within a polycentric region that contribute to human wellbeing?

The following sub-questions were also addressed within this research:

1. What are the specific spatial attributes and physical characteristics of peri-urban green spaces and green structures within a polycentric region in a fragmented state?
2. Which are the types and what are the eco-spatial characteristics of polycentric spatially fragmented green structures that are conducive to particular human well-being benefits (e.g. psychological, social and/or physical wellbeing)?
3. What types of people use what types of polycentric green spaces and green structures for what types of human wellbeing benefits?
4. What type of peri-urban green space assemblages provide the most affordances or highest performance aspects to human wellbeing measures and ecological integrity?
5. How can landscape planning and design in the context of dynamic polycentric urbanising landscapes contribute to improving human wellbeing?

1.5 Research Plan Overview

This research investigates the relationship between peri-urban green space landscape fragmentation and quality of life through a mixed-method approach within a case study framework. Utilising prior theoretical knowledge within an abductive framework and proven methodological approaches, the study measures the impacts of green space and green structure fragmentation upon human wellbeing using both spatial and aspatial data sources collecting qualitative and quantitative evidence (See Figure 1.1: Research Plan).

Specifically, this research integrates the findings of a socio-cultural analysis assessing human wellbeing benefits afforded through green space interaction and a landscape analysis evaluating patterns of landscape fragmentation and the resultant physical characteristics and spatial structure of the peri-urban green space. Results illustrate causal links between the case studies' polycentric, peri-urban interstitial green spaces and human wellbeing benefits achieved through interaction within their physically fragmented context.

Glasgow in Scotland and Helsinki in Finland are used as case study regions due to their distinctly polycentric morphologies and notable quality of life rankings (See Chapter 7) to apply the data collection, testing, and analysis. The methodologies employed provide an understanding of how landscape and urbanisation mutually affect one another in terms of spatial patterns and human wellbeing and how these can be integrated better. Complementing traditional ecological knowledge, Gibson's Affordance Theory (1977) provides the theoretical context for studying this human-nature relationship, while the DPSIR (Driver-Pressure-State-Impact-Response) framework, a modified P-S-R (Pressure-State-Response) model (EEA, 2011), captures causal links between spatial components found within the landscape.

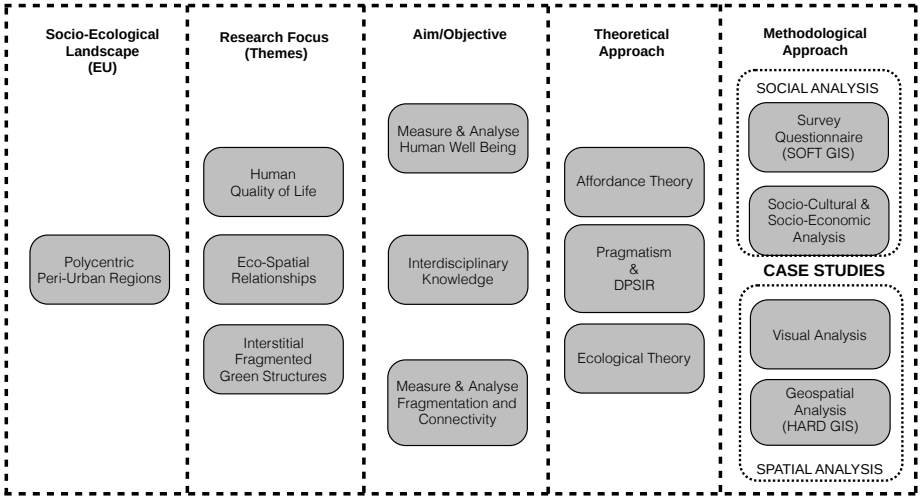


Figure 1.1: Research Plan Overview

1.6 Significance of Research and Original Contribution to Knowledge

This research contributes to a greater understanding of the interdisciplinary relationships between green structures and human wellbeing benefits in order that this knowledge may be accounted for in the spatial planning process and the design and management of future urbanising landscapes.

The need for this research arises from the fact that, in urbanising environments, there are constant pressures for change to the landscape. In this context, the emergent question is how can we positively affect the spatial planning process? This research provides a means to gain a better understanding of the factors and characteristics specific to the interstitial green structures in these environments and how these affect specific ecosystem service delivery. An important contribution of the research is the identification of specific green space characteristics found within configurations of green structures that influence human wellbeing benefits such as forests and public parks.

It is unclear what the consequences of peri-urban landscape fragmentation might be for residents and therefore a greater understanding of the interactions between people and nature in this context is required. The outcome of this study provides designers, planners, managers and policy makers with information to make effective decisions in the spatial planning and design of these urbanising landscapes, and their green structures, so that their inherent human wellbeing benefits are not displaced and/or forfeited in the development process. In so doing new and beneficial information is contributed that supplements the existing knowledge base surrounding planning theory.

1.7 Research Structure

This thesis is organised into three distinct parts. Part I comprises Chapters 2 through 5, serving to establish the context and background for the study, explain the issues of concern, define key terms and concepts, and explore the historical, theoretical and research context for the relationship between spatial planning, green spaces and human wellbeing. Chapter 2 provides a detailed explanation and analysis of the key terms and concepts surrounding landscape and socio-ecological integration within landscapes, while Chapter 3 reviews human development

patterns and their associated impacts. This Chapter also provides operational definitions for the conceptions of urbanisation, landscape fragmentation, and green space. Then, Chapter 4 reviews the literature specific to quality of life and human wellbeing, and the various theories used to capture the relationship between humans, green spaces, and wellbeing. Chapter 5 ends the first part of the thesis with a review the research's primary theory – Affordance theory and an introduction into landscape of affordances within the human – nature relationship. Part II is limited to Chapter 6, and describes the strategy and methodologies used to answer the research objectives and questions. Part III presents the case study analysis (Chapter 7) followed by its spatial landscape analysis results (Chapter 8) and socio-cultural analysis results (Chapter 9). Chapter 10 reports the research's main findings and discusses the results and Chapter 11 concludes with this research's contributions, strengths and limitations, and implications for future research as well as policy, planning and landscape architecture. Appendices are provided at the end of the thesis.

Chapter 2 - The Integrated Landscape

2.1 Introduction

The next three Chapters define key terms and concepts used throughout the thesis including landscape, urbanisation, polycentric development, landscape fragmentation, green space and green structures, and lastly, life satisfaction and human wellbeing. Together, these Chapters present the historical and theoretical context for the research surrounding the human-nature relationship, and specifically the process of urbanisation within Europe and the resultant diverse impacts on green structures and human wellbeing. This includes a review of the existing literature that serves to set out the background to the research, identifies gaps in existing literature and research, facilitates its methodological approach, provides operational definitions, and illustrates the relevance of this study. The empirical analysis and results of the literature review is located in Appendix 1.

In order to understand the relationship between the landscape, with its various green spaces and green structures, and human wellbeing, we must first arrive at an understanding of the concept of landscape itself. This is the focus of this Chapter.

2.2 Landscape

'Landscape' is a ubiquitous concept intersecting multiple and diverse fields of study including geography, the social sciences, environmental studies, landscape architecture, ecology, arts, planning, public health, psychology, humanities and philosophy. The following sections provide an historical and theoretical basis from which to view the idea of landscape from an inclusive and interdisciplinary viewpoint, and support an interpretation of the landscape as a comprehensive spatial construct in which the relationship between humans and nature plays out.

2.2.1 Frameworks for Understanding the Concept of Landscape

The scientific literature provides many perspectives when discussing 'landscape'. For instance, the landscape may not be considered an entity per se, but a conceptual framework (Appleton 1975; Gibson 1979; Bourassa 1991) or

solely as a functional ecological space (Wiens et al. 1993; Hobbs 1997) or a domain (Bastian, 2002) in which to study systems and interaction processes.

This discussion of the concept of landscape does not provide an in-depth investigation across disciplinary fields such as those concerning philosophical studies, ethics, aesthetics, phenomenology, and others (e.g. Appleton 1975; Bourassa, 1991; Barker, 1968; Kaplan, 1989**)**, but their various aspects are introduced where they can provide clarification.

In order to arrive at an operational definition of landscape for this research, four distinct frameworks for the concept of landscape are prevealent in literature:

- Physical;
- Qualities;
- Features;
- Function.

The landscape can be defined by its physical characteristics, or its shape, form, structure and pattern. It may be a large forest with areas of rural residences, or a suburban area with many small zones of woodland. The landscape can also be described in terms of its qualities - dense or open, wild and natural or urban. Thirdly, the landscape may be defined by its features (e.g. hedges or windmills). Finally, the landscape may be defined by its function or processes, such as the recharge of groundwater resources, which occurs through various processes and interactions of elements within the landscape. Each of these concepts serves to present an important aspect of the spatial-based, contemporary, landscape while emphasising that an operational definition for this research needs to integrate these perspectives.

Landscape as a Physicality

The most tangible of these concepts, the physical landscape, can be described in terms of its shape, form and pattern, or its landscape structure. Both the composition and configuration of the landscape's physical elements, whether natural (e.g., topography, geological features such a mountains and soils, vegetation), or human (e.g. buildings, roads, agricultural fields), create a landscape's structure. Composition is aspatial information, specifying the number

and abundance or types of those physical landscape elements considered. The configuration of a landscape, meanwhile, is defined by its spatial arrangement and the overall context of landscape elements. Together, the composition and configuration of its landscape elements define the physical landscape's structure (e.g., Li and Reynolds, 1993; Forman and Godron,1986).

Landscape as a Quality

Examples of a landscape's qualities include an appreciation for its beauty or history, the sense of wildness, or its challenging physical recreation. A landscape may be considered as safe or unsafe. Efforts to quantify these various qualities of the landscape are ongoing within academia and practice (e.g. UNESCO, 2012; NPS, 2008), and often do not translate beyond individual studies due to contextual limitations such as those within distinct urban conditions or rural and wilderness.

Furthermore, landscape quality is a subjective interpretation, dependent upon individual perception (Bailly et al., 1980). In fact, landscape has been described as not a physical entity at all, but only a mental representation (Bailly et al., 1980; Cosgrove, 1984; Entrikin,1991) specific to those qualities the landscape provokes. Although the concept of landscape may still be spatial, this is within a mental representation only.[1]

Additionally, other intangible interpretations of landscape include socio-economic or solely economic considerations (Barker, 1968; Golledge and Stimson, 1997; Farina, 2000). Due to the contextuality and subjectivity of this concept and varied interpretations of this non-physical concept, it shall not be explored in further detail.

Regardless of the landscape's physicality, academic literature has provided a strong basis on which landscape qualities are commonly defined such as the landscape's degree of naturalness (e.g. Westhoff, 1983) and its association to mental relaxation as studied through Attention Restoration Theory (Kaplan and Kaplan, 1989). A significant field has developed regarding landscape aesthetics,

[1] The discipline of phenomenology has gained recognition in the social sciences and physical planning fields in the last decade. See works by Maurice Merleau-Ponty, Alfred Schutz, Martin Heidegger, Arnold Berleant, and Christopher Tilley.

which focuses on the landscape's visual qualities and the effects these may have on aesthetic experience and as a visual amenity (e.g. USFS, 2002, Gobster 1999; Kaplan and Kaplan, 1989). This description of landscape as an aesthetic overlaps with the other concepts discussed.

Landscape as a Feature

The 'landscape' can be defined by its individual or groupings of features. This definition refers specifically to those visible features and includes both natural elements such as mountains and lakes, and human elements such as buildings and structures. What makes this concept different from the physical landscape, however is that these elements have a distinct human-influenced predisposition to them: landscape features take on human-induced names such as a meadow or hedge and are often socio-culturally determined, giving it a certain 'character' (Landscape Institute and IEMA, 2002; NPS, 2015).

Landscape as a Function or Process

The landscape can also be defined through its functions or various processes, or how the various landscape elements act and interact. For example, the process of groundwater recharge occurs through various interactions of elements within the landscape - the roots and leaves of plants, the geology and soil characteristics, and even evapotranspiration, all affect the groundwater recharge process in unique ways.

As noted by Forman and Godron (1986, p.11), landscape function is comprised of *"the interactions among the spatial elements, that is, the flows of energy, materials, and species among the component ecosystems"*. Coley et al. (1997), meanwhile, state that the functions and functional interactions between the landscape elements provide insights into the various relationships within the systems.

Landscape functions and processes are an integral component in the discipline of landscape ecology; specifically, the composition, structure and function of landscapes. Interestingly, among many European landscape ecologists, the term 'landscape function' stands more for the performance of a landscape in the broadest sense, rather than for processes and fluxes of matter, energy and

species. de Groot (1992) defined landscape functions as "*the capacity of natural processes and components to provide goods and services, which satisfy human demands directly or indirectly*."

Landscape Framework Summary

The landscape is a difficult concept to clearly define due to its mix of subjective and objective perspectives and contexts, including the socio-cultural perspective. For the purposes of this research, therefore, the landscape will be regarded through the pattern, shape, arrangement and quantity of the different components and features within the area of study. This conceptual framework is the guideline utilised when considering the different methods available to analyse landscapes (See Chapter 6). All four of these concepts are true when discussing the concept of landscape: The landscape is an area of land (at any size and scale) whose mountains and lakes can be wild and beautiful or whose cities and buildings can be ugly and dark and in which we play and laugh or are alone and quiet, and which all interact together.

2.3 Landscape as a Spatial System

Moving forward, there are significant concepts that must be clarified. First, there are many other possible perspectives for defining a landscape and one definition will not work in all contexts. Second, landscapes vary significantly; landscapes vary in structure (physical) and function (process) due to biophysical and human factors. Importantly, landscapes are spatially explicit, and encompass a wide range of spatial and temporal scales (Liu and Taylor, 2002). Lastly, defining the concept of landscape is contextual: contextual in terms of perspective, contextual in terms of research objectives, and contextual in terms of scale and time.

The term environment is commonly used within literature. The environment can be considered as the medium within which systems and their various individual elements function (Laszlo and Krippner, 1998). Landscapes are dynamic, and the spatial analysis of any complex system where various phenomena occur is difficult. In this research, the terms spatial and spatio-temporal are used interchangeably; both refer to data and phenomena or

relationships with both spatial and temporal dimensions of variation. The human-nature relationship is dynamic, thus spatial relationships are dynamic.

Within the spatial concept of landscape, two principal interpretations emerge, each of which integrates the various aspects of landscape and begins to view landscape as a multi-dimensional, interdependent system. German geologist Guenter Haase, in 1979, subdivided the landscape 'sphere' into a natural sphere (Natturraum) and an anthroposphere (Kulturram). This delineation was one of the first to recognise the ongoing impact of humans on the natural environment. The term anthrosphere is now common in literature and has even gained attention as the current epoch in geological history, the Anthropocene, which recognises the human impact upon the earth's ecosystems (Crutzen and Stoermer, 2000). A more simplified view of the concept of landscape has evolved in the literature, however, that coalesces various aspects of landscape into two distinct perspectives: the natural or biophysical landscape and the human or anthropogenic landscape.

2.3.1 The Biophysical Landscape

The biophysical landscape includes all the biotic/abiotic factors and resources of the natural environment. Perhaps the most prevalent description of landscape as a spatial concept is provided in the natural science discipline of landscape ecology.[2] Ecology is a wide-ranging biological science entailing the study of the interaction between living things and their environment (Sutton and Anderson, 2004). Landscape, from an ecological perspective, is a mosaic of interacting ecosystems (at multiple scales).

The traditional definition of an ecosystem is that it is a biological system, comprising abiotic and biotic features (e.g. Odum, 1971). Perhaps oversimplified, ecosystems are real-world, spatial elements that one can observe and measure, albeit with a recognised degree of uncertainty due to their complex nature (Pickett et al., 2001). The concept of the biophysical landscape, however, differs from the traditional concept of the ecosystem in that the former focuses on groups of

[2] Ecology and landscape ecology are vast disciplines, therefore only concepts relevant to this applied landscape architecture and environmental psychology study will be introduced.

ecosystems, and the interactions among them, whereas the latter focuses on spatial heterogeneity and its impact on process and function.

Landscape ecologists Forman and Godron (1986) define landscape as *"a heterogeneous land area composed of a cluster of interacting ecosystems that is repeated in similar form throughout"* (p 11). Turner and Corlett (1996), meanwhile, define landscape as an area that is spatially heterogeneous in at least one factor of interest. Landscape ecology emphasises variation in both spatial and temporal scales; landscape ecology also recognises that humans are but one agent affecting landscapes.

2.3.2 The Anthropogenic Landscape

The anthropogenic landscape includes all the socio-cultural factors and resources of the built or human-impacted environment. It emphasises the impacts of human activities on the natural landscape, often with a generation of some material output or product intended to provide benefits to humans.

The concept of an anthropogenic landscape actually has a long pedigree under a variety of names. The term cultural landscape was discussed by human geographer Carl Sauer (1925), who noted that the cultural landscape was a result of the natural landscape being manipulated or changed to meet human needs, whether by local practices (e.g. agriculture, rice fields) or cultural traditions (e.g. cemeteries, burial mounds). Significantly, Sauer's discussion retains the physicality of the landscape, but acknowledges human culture as a factor affecting its structure (i.e. shape, form and pattern).

The Integrated Concept of Landscape

Overall, these two principal interpretations of the term landscape are the most common in the spatial planning and natural science literature. The biophysical landscape can be considered as a pre-anthropic landscape in its explicit definition, but the anthropogenic interpretation is widely accepted as the current state – to varying degrees – of most landscapes within the earth's biosphere. Thus, most landscapes are part biophysical or natural and part anthropological or socio-cultural.

Biophysical interpretations of the term landscape emphasise that a landscape is primarily a natural phenomenon, and that landscapes develop through biophysical processes. The pattern, configuration and spatially explicit features specific to processes within landscapes dictate that the spatial scale must be considered (Allen and Hoekstra, 1992; Wiens, 2005). While landscape ecology is primarily interested in landscapes' spatial and, to a lesser degree, temporal scales, its application to management and spatial planning also requires that the social aspect be considered (Field et al., 2003; Angelstam et al., 2013).

In contrast to the 'biophysical unit', the anthropogenic concept of 'landscape' includes elements that are not only impacted by the natural context (i.e. natural phenomena) but also by human influences. A landscape's natural or biophysical characteristics are shaped by socio-cultural influences. "*Landscape is a space–time construct which is determined by the flows of matter and energy between man and nature*" (Haase 1991). In other words, biophysical landscapes are formed by natural processes (i.e. its structure), while anthropological landscapes represent the interaction between the biophysical structure, land use, and other human activity.

Both of these primary interpretations of the concept of landscape clarify frameworks to analyse the spatial landscape. This research seeks a truly integrated concept and definition of the term landscape, wherein human and natural processes both interact with one another; where the biophysical landscape (its forms, patterns and processes) influences human action directly and indirectly to change the biophysical landscape (Nassauer 1992; Gobster et al., 2007). This integrated concept of landscape is not without precedent (e.g. Hägerstrand, 1985; Corner, 1999; ELC, 2000; LCA, 2002; Antrop, 2004; Natural England, 2007; Selman, 2009).

2.3.3 Urban Ecosystems as an Integrated Landscape

Most of the world lives in urban environments (WHO, 2014). Urban ecosystems are now generally recognised as unique environments encompassing humans and life forms within urban areas, as well as the non-living structures and processes with which they interact. The landscape patterns and forms found here

differ from other, more natural or biophysical ecosystems – they can include canals, roads, buildings, gardens and many others. Urban ecosystems include built infrastructure as a significant proportion of land and those in which people live at high densities (Pickett et al., 2001).

This research shall not utilise the term urban ecosystems, rather focussing on more interdisciplinary terms to describe its characteristics (See below) within the concept of an integrated landscape. Landscape, for the purposes of this research, follows the generally accepted definition, i.e., it is the cultural (social) and natural (ecological) interactions between people and the environment.

Regardless of how landscape is defined, the 'concept' of a landscape is clear. All landscapes have a user-defined structure (pattern) that is hypothesised to influence its function (process). This interaction between anthropic spatial pattern and biophysical process defines this research's comprehensive concept of landscape as a coupled biophysical system and anthropogenic system – a socio-ecological landscape (SEL).

The literature utilises terms such as 'coupled human-environment systems', 'ecosocial systems' and others to illustrate the interplay between social and ecological landscapes[3]. Sometimes referred to as a *"human-environment system"* (Turner et al., 2003), various disciplines utilise the term but it has been noted that it is an unclear term which facilitates interdisciplinary communication and diverse applicability (Liu et al. 2007; Becker, 2012). Although the social and ecological components of SELs may be readily identified, it is difficult to study and analyse

[3] The literature within the social sciences and spatial planning disciplines primarily utilises the definition of socio-ecological systems provided by the Stockholm School, as nested, multilevel systems that provide essential services to society such as supply of food, fibre, energy and drinking water (Berkes and Folke, 1998; Resilience Alliance, 2007). More formal definitions refer to linked social and ecological systems, for example to "*ecological systems intricately linked with and affected by one or more social systems*" (Anderies et al., 2004). Within a systems approach (SES serves as a framework and organising tool used by researchers to understand complex, interconnected, social and ecological systems.

them separately - SELs have forms, patterns, structures and functions that cover many spatial and temporal scales.

2.4 The Socio-Ecological Landscape

The concept of socio-ecological landscape (SEL) can be illustrated through this Chapter's two principle interpretations: biophysical and anthropogenic. Biophysical systems have been altered by anthropogenic systems through the sustained, direct human interaction with natural ecosystems. And the biophysical systems have responded through their physical changes (e.g. function). When these two systems function together, intradependently, that can be referred to as the SEL.

These two intertwined concepts of landscape each share processes that present the conditions for other processes to occur. And it is these integrated processes that in turn start to create landscapes, or the environment humans inhabit - the SEL (Trees, 2001). In this more comprehensive perspective, humans become ecological engineers and designers, adapting ecosystems and nature to their benefit, which in turn impacts the biophysical landscape, which in turn affects the functioning of ecosystems and, thus, human actions, again, in a cyclical format (e.g., Zonneveld, 1995). However, identifying and analysing SELs within the complex nature of interactions between its biophysical and social system components acting at different scales makes it difficult to assign clear spatial boundaries (Cilliers, 2001; Folke, 2007)

The landscape is complex: it is both spatial and aspatial, quantitative and qualitative, urban and non-urban. The SEL concept is more complex than current definitions of urban ecosystems. Innovative definitions and concepts are therefore required. There may never be a unified concept of landscape, although there have been distinct demands (e.g. Weber et al., 2006; Daniels, 2009; Wu, 2006; Berkowitz et al., 2003; Wiens, 2005; Potschin and Haines-Young, 2006). Although the advancement of various theoretical frameworks provides further integration of human and ecological systems that allows for wider applications in the various social science and natural science disciplines (Berkes, Colding and Folke; 2003), developing strong theoretical foundations for exploring the human-

nature relationship is critical to the continued success of life on earth. The study and modelling of this relationship delivers important measurable variables that can be studied and analysed, even within varied contexts and disciplines. As interdisciplinary knowledge within academia has increased, new paradigms have evolved which offer unique perspectives on complex SELs.

The critical paradigm to understanding the SEL and its functions and processes is that it is a complex, interrelated system. Further study into systems and systems theory is not required for this Thesis but can add to future research and transdiciplinary studies. The works of von Bertalanffy (1968) and others assist in better analysing and understanding complex relationships and interactions among the various parts of elements that connect a system, i.e. the landscape, as a whole and serve to govern their organisation (i.e. systems thinking per Golinelli, 2009). Overall, systems theory is a theoretical perspective that analyses landscape phenomenon viewed as a whole and not simply the sum of elementary parts. The focus is on the interactions and on the relationships between parts/elements (e.g. humans and nature) in order to understand the landscape's patterns, forms and processes or its functions.

2.5 Landscape Summary

Of the many characteristics found within landscapes, the concept of physical connectivity provides knowledge valuable to discussions within SELs and the human-nature relationship specific to this research's focus of landscape fragmentation and human wellbeing. In SELs, the various components or elements that compose a system must be able to connect and interact with one another for the system to succeed and thrive. This interaction (i.e. a behavioural component of systems) is critical because it provides the system with feedback and enables modification or emergence to occur for the benefit of the system overall. In this regard, the behaviour which occurs between the elements is viewed as more important than the individual elements themselves.

In summary, SELs acknowledge the biophysical landscape or ecosystem as not a static, singular component, but a complex, multi-layered environment that is formed and organised through human and ecological processes (Abel, 1998). They

are hybrid ecosystems – part ‘urban ecosystems’ and ‘social ecosystems’, part ‘natural’ ecosystems. Systems thinking and the concept of ecosystems have broadened to incorporate humans, not just as outside disturbances but as integrated with other biological and physical processes and structures (McDonnel and Pickett, 1993; Collins et al. 2000; Grim et al. 2000; Liu et al. 2007; Alberti, 2008; Wimberley, 2009). SELs are multi-functional landscapes (Hansen, R. and Pauleit, S., 2014) providing both biological and anthropological benefits. It is this comprehensive, integrated paradigm to the landscape that this research embodies. This research will focus on a specific socio-ecological landscape – the peri-urban landscape found within and around Europe’s mid-sized, polycentric city regions.

Chapter 3 - Human Development Patterns and their Impacts upon the Landscape

3.1 Introduction

This Chapter continues the human-nature relationship literature review; it defines key terms and concepts used throughout the thesis when discussing human spatial development patterns and their effects upon the landscape. In order to study the SEL, specifically the peri-urban landscapes (PUL), and the human-nature relationship, particularly from the perspective of spatial planning and the design disciplines, further detail is required:

- What are the specific biophysical and anthropocentric components found within the PUL under investigation?
- What are the forms, patterns and processes that require study within the PUL and how are they important to the human-nature relationship?
- What are the characteristics found within the PUL that affect the human-nature relationship and human wellbeing?

3.2 Urbanisation

Humans have modified the landscape for centuries in order to meet their needs and goals (e.g. Castells, 1996; Diamond, 1997). The last two hundred years, however, have brought particularly significant change to the landscape, most notably through population increase and the requisite infrastructure to meet human demands – referred to simply as urbanisation. This section will answer the following questions:

- What is urbanisation and how is it defined?
- Why does urbanisation occur?
- How does urbanisation occur?
- What is the current state of urbanisation in Europe?
- What impacts upon the physical landscape does urbanisation bring?
- Are there ways to measure urbanisation?

Although different definitions exist for urbanisation, it is generally accepted that urbanisation involves the transition in population density from rural

to urban settlements. Urbanisation is not just urban population growth or the expansion of urban land cover; literature frequently refers to changes in land use (i.e. urbanised - often through the human development process) that implies that when a region is urbanising it is becoming more urban through increased population (United Nations Population Division, 2014). This is a common misconception regarding urbanisation, since in reality urbanisation occurs in very dense and urban areas as well as more rural regions.

Urbanisation is a complex social, economic, political, and technological process, and there are no uniform patterns of urbanisation from which to draw sound conclusions or definitions. Urbanisation, then, simply summarised for the purpose of this reserach, is understood as the density and distribution of human development within the landscape.

The process of urbanisation comprises the physical conversion of open, non-built areas for human settlement purposes (EEA, 2011). Urbanisation is primarily the outcome of demographic transition – whether (net) migration from rural to urban areas or from urban cities to rural areas. Urbanisation can include the formation of new urban centres or the spatial expansion of existing ones. Urbanisation, however, is not invariably predicated upon urban expansion, it can also occur through decentralisation.

Although the increase in urban populations is an important driving factor of urbanisation (UNEP, 2007; Loibl and Bell, 2011), in Europe, it is not the main factor. More significant is the trend for European cities to become less compact. Since the mid-1950s, European cities have expanded on average by 78%, whereas the population has grown by just 33% (Haase, 2014). Over the last few decades, continuous urban expansion at rates much higher than population growth has resulted in a massive extension of the urban footprint on Europe’s landscape (Kasanko et al., 2006)

Urbanisation is a process that has a significant affect upon the landscape. The most significant visible change is that the process of urbanisation creates more urban areas. But what are urban areas, and can they be measured? The natural and social sciences offer differing definitions for ‘urban’: in the social sciences, urban

is often defined based on population density. For example, the Organisation for Economic Co-operation and Development (OECD) states that an area is considered urban if it has a minimum population density and number of people. Ecologists, conversely, define 'urban' in terms of land cover (i.e. impervious land cover vs. vegetative land cover)

One way to visualise urbanisation and urban areas is through a 'transect'. This is a visual planning tool that helps categorise different human development patterns by shared characteristics (PLUREL, D2.1.1, 2011). A transect evaluates spatial density, building form, infrastructure systems and ecological systems to create explicit "Transect Zones" or "T-Zones". In the spatial landscape, the urban-to-rural transect is a modelling tool that expresses categories of urbanisation along a continuum from undeveloped natural areas to dense urban cores (See Figure 3.2). Similar to ecological organisations of plant and animal communities, which classify key characteristics of habitat and diversity, the urban-rural transect provides a set of characteristics to categorise differing levels of urbanisation along different zones of the rural-to-urban continuum. The urban-rural transect (See Figure 3.1) provides a coherent illustration of the various zones of urbanisation or urban-rural gradient typologies. However, these illustrations are not uniform in all contexts, but serve as a generic model to analysing SEL's and the process of urbanisation.

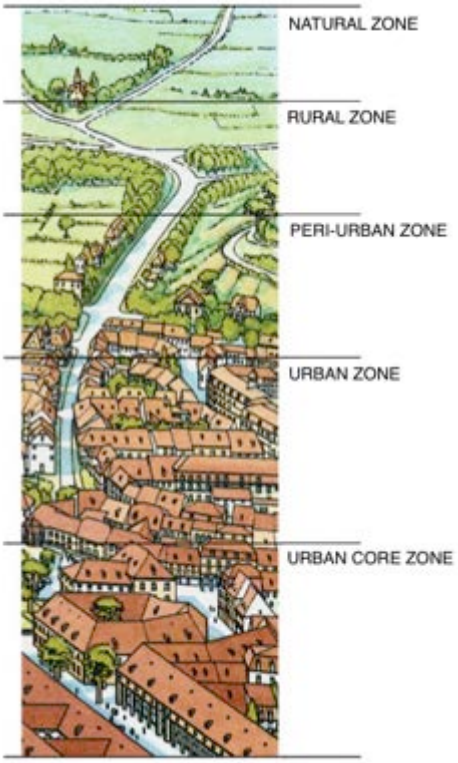


Figure 3.1: Urban-Rural Transect Model

Illustration from the early plan for Echternach in Luxembourg. It is a vignette extracted from a full drawing that is eight times the width.

(Source: Leon Krier, Drawing courtesy of Duany Plater-Zyberk and Co.)

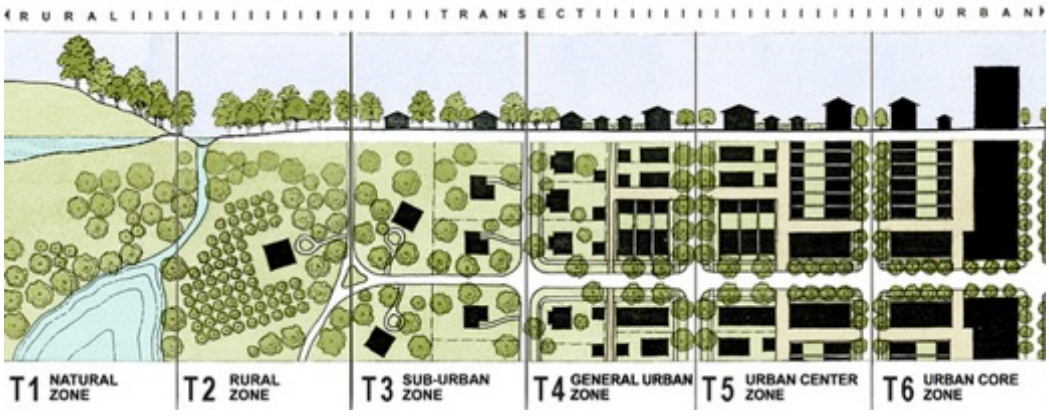


Figure 3.2: Urban-Rural Transect

One way to analyse urbanisation and urban areas is through a transect. A transect is a visual planning tool that helps categorise different human development patterns by shared characteristics

(Source: Center for Applied Transect Studies)

The impacts of urbanisation are complex and occur at different scales, however many of the processes involved include a spatial dimension and are thus able to be quantified, analysed and visualised using techniques such as geographic information systems (GIS) and remote sensing (e.g. satellite images, orthophotographs). The measurement of impacts often utilise the urban gradient approach (McDonnell et al., 1997, Alberti et al., 2001) that focuses on distances to city centres and human density.

Additionally, the literature provides a common approach to measuring urban areas through its land cover and/or land use. Although these terms are often applied to landscape classification, particularly in the natural sciences, they have proven useful in the spatial planning disciplines as a modelling tool. Land cover and land use both refer to the biophysical and ecological conditions of the landscape, however, subtle yet significant differences exist between them.

Land cover refers to the physical appearance of the land surface (Turner and Meyer, 1994; UNEP - FAO, 1999). Land use refers to its human purpose (e.g. =agriculture, pasture, forestry, or human settlements) (Turner and Meyer, 1994). Put simply, land use infers the 'purpose of' the landscape (e.g. playing field) whereas land cover may be understood as the 'manipulation of' the landscape to create a physical structure (e.g. grassed area).

Both land cover and land use change over time. Both terms serve as an analytical tool to be used within landscape analysis. The drivers and pressures of anthropic activity create the current states of land cover and land use that are investigated in this research. It is these states that affect the relationships between humans and the landscape - the spatial patterns and the SELs - through the changes to the biophysical landscape, or land cover/land use, particularly through the process of urbanisation and the creation of urban areas.

3.2.1 Sprawl

Sprawl is a common characteristic of the process of urbanisation and its resultant spatial change, particularly within PULs. Although there has been much discussion of sprawl, it is a difficult concept to define. Sprawl is regarded as the

expansion of metropolitan areas following population growth and is characterised by ‘haphazard’ or unplanned growth (Peiser, 1984).

Though often defined by its characteristics, sprawl is an urban expansion process (EEA, 2011), not a product or outcome or urbanisation. It is an overall term for the ‘growing out’ of human development within urban centres into the less-urban landscape such as the agricultural areas beyond the city limits. Sprawl often includes rapid, discontinuous and decentralised (i.e. scattered) forms of urban expansion (Tsai, 2009).

Oueslati et al. (2015) characterise sprawl as a multidimensional phenomenon *“typified by an unplanned and uneven pattern of urban development that is driven by a multitude of processes and which leads to the inefficient utilisation of land resources”*. Sprawl development is patchy, scattered and strung out, with a tendency for discontinuity. Sprawl patterns leap-frog or ‘jump’ over certain areas, leaving undeveloped ‘open’ spaces.

Although sprawl was first observed in United States cities during the middle 20th century and associated with the low-density outward expansion of its cities, it is now a global phenomenon. In Europe, where cities were traditionally much more compact, urban sprawl is now commonplace and is regarded as one of Europe’s major challenges (e.g. Hasse and Lathrop, 2003; Kasanko et al., 2006; PLUREL 2013).

Sprawl lacks a distinct and agreed definition, as well as measurement tool. The EEA has utilised different measurements of sprawl in various studies. One measures the spatial scale of urban areas such as cities through total artificial area (ArtifArea) using CORINE Land Cover data (Coordination of Information on the Environment Land Cover, CLC) or MOLDAN analysis (MOnitoring LANd use/cover Dynamics) which focuses on land use/land cover change over time only. Although these measures provide an overall quantification of urban area, they do not provide information on the quality of the composition (i.e. scattered/decentralised development pattern) or the urban spatial qualities (i.e. morphology).

The prior sections have provided definitions, measurement methodologies, and a literature review of spatial change in the process of urbanisation and its most notable characteristic - sprawl. Sprawl creates distinct patterns and forms upon the landscape. These spatial characteristics are most noticeable in non-urban areas since sprawl is located at the edge of urban growth. The next section will focus on a specific spatial area within the rural-urban spectrum, i.e. peri-urban areas, and a specific process of urbanisation within this area, peri-urbanisation, in order to better comprehend human development's impact upon the landscape.

3.2.2 Peri-Urban Areas and Peri-Urbanisation

Peri-urban areas (PUA) are the transitional area between urban and rural landscapes; they exist at the intersection of rural and urban zones, often where infrastructure such as roads and economic centres exist, just beyond the existing urban areas (See Figure 3.1).

A PUA is commonly defined as a "*zone of transition from urban to rural land uses*" existing between the outer limits of the urban area and the beginning of the rural area (Davis et al., 1994, p. 46). PUAs have been defined in literature in relation to a nearby urban area on their inner boundary, a rural area on their outer boundary (Houston, 2005), or as the land in between these two boundaries – a 'middle landscape'. Sometimes referred to as the 'peri-urban interface' in literature,[4] PUAs, simply, are urbanising land adjacent to the edge of an urban area into which it physically and functionally expands (Burnley and Murphy, 1995; Iaquinta and Drescher, 2000). Additionally, PUAs are examples of the integrated socio-ecological landscape discussed previously (e.g. Keys, Wentz, and Redman, 2007; Mattingly, 2006).

PUAs have had been referred to in many ways in the literature, such as 'fringe', 'exurban areas' (e.g. Crump 2003), 'peri-metropolitan' (Houston, 2005), 'rural-urban fringe', city edge, metropolitan shadow, and others. None of these

[4] Peri-urban interface (PUI): zone of (dynamic) transition or interaction between urban and rural areas; usually used in the context of rapidly urbanising poor countries

terms entirely succeed in capturing their unique qualities, however. For example, a PUA is not an exurban area. Exurban areas are already urban, they are just spatially located beyond the suburbs of urban centres. Fringe or urban fringe areas are also already urban, this term refers to the artificial border between urban development and rural land uses. Regardless of its moniker, however, PUAs have distinct characteristics - they exhibit sprawl characteristics and are where urbanisation and sprawl are most visually noticeable (Gallent et al., 2006). PUAs *will become* urban, but have not yet. It can be conceptualised that PUAs are the hot-spot for continued urbanisation due to their proximity to existing urban areas. In Europe, the term 'peri-urbanisation' is used to denote similar dynamics and development typology to that of 'urbanisation'.

The most noticeable outcome of peri-urbanisation and sprawl is the change to the land cover, often from agricultural or green space to housing and/or commercial land cover (CEMAT, 2007); referred to as the 'green to grey' transformation. Indeed, sprawl originates in the peri-urban area (Leontidou and Couch, 2007). Overall, the land cover that was once a vegetative quality changes to decreasing levels of vegetative intensity with more impermeable surfaces such as rooftops and paving.

In Europe, sprawl occurs on the edges of cities and urban areas but also in the spaces between them. Whereas 'sprawl' is an outcome of the urbanisation process, as described previously, 'peri-urbanisation' denotes a more active term encompassing the dynamics of urban development that lead to a 'sprawl' condition (EEA, 2006). In terms of shape rather than processes, peri-urbanisation results in a peri-urban landscape that is compositionally more heterogeneous, geometrically more complex, and ecologically more fragmented than the non-urban or rural lands. (Galster et al., 2001; Zhang et al., 2004).

The process of peri-urbanisation often leads to a spatial re-structuring of both the PUA and the larger region. As urban areas expand outwards from the more central urban areas or cities, they eventually form their own unique city-centres with smaller yet similar services and functions as the larger urban centre from which they grew. As these new peri-urban centres continue to expand and

grow, the process of peri-urbanisation and sprawl creates a distinct urban form upon the landscape, notably, the creation of these smaller city-centres, or sub-centres (PLUREL, 2013), often referred to as 'satellite cities' (Garreau, 1991) or 'suburbs' within the larger peri-urban region (PUR).

3.2.2.1 Cities and Peri-Urban Regions

The term 'city' can refer not only to its figurative conditions (e.g. urban, land cover, land use) but also its physical arrangement and infrastructural characteristics. The city designation most often occurs through population metrics including density and even by means of administrative control boundaries.

Cities are complex entities; they are mutable and can be approached through different definitions and delineations. John Friedmann (1986, p. 70) referred to cities as a *"spatially integrated economic and social system at a given location or metropolitan region"*. EPSON, the European Spatial Planning Observation Network, a significant and influential research programme focusing on urban development and the impact of EU policies in European regions, offers important concepts into the spatial understanding of cities and their regions. EPSON (2006, 3.1) designates cities as *"morphological agglomerations characterized by high density and/or by contiguous urban fabric"*.

The literature refers to an agglomeration, often called an urban agglomeration, as an extended city or town area that includes a series of central-areas (i.e. sub-centres) connected within a continuous urban area (e.g. INSEE, EUROSTAT). The term agglomeration is similar to another common term in literature - conurbation. Conurbation is a more specific concept for a large urban region encompassing multiple cities, towns or urban areas, or including more than one agglomeration. Conurbations are merged individual agglomerations to become one larger, continuous urban area or metropolitan region. Patrick Geddes (1915) introduced the concept of conurbation to describe the urban regions that have grown beyond the historical boundaries of their core cities. A conurbation has multiple sub-centres within a single built up area (Gordon et al., 1986). For example, the Rhine-Ruhr metropolitan area (*ballungsräume*) in Germany, sometimes referred to as Essen-Düsseldorf, is a large continuous urban area that

contains the cities of Dusseldorf, Essen, Dortmund and others. The Randstad in the Netherlands, meanwhile, is another example of a conurbation, including the cities of Amsterdam, Rotterdam, The Hague and Utrecht (See Figure 3.4). Both these conurbations include large, continuous and contiguous urban areas that encompass various urban agglomerations.

Although city can refer to an agglomeration including suburban and satellite areas, the term is not usually applied to a conurbation (i.e. cluster) of distinct urban places or sub-centres, nor for a wider metropolitan area including more than one city, each acting as a focus for parts of the area. These delineations are often scale-dependent and cause confusion since they can be elaborate and inconsistent (e.g. EPSON's Functional Urban Area (FUA) and Urban Morphological Zone (UMZ).

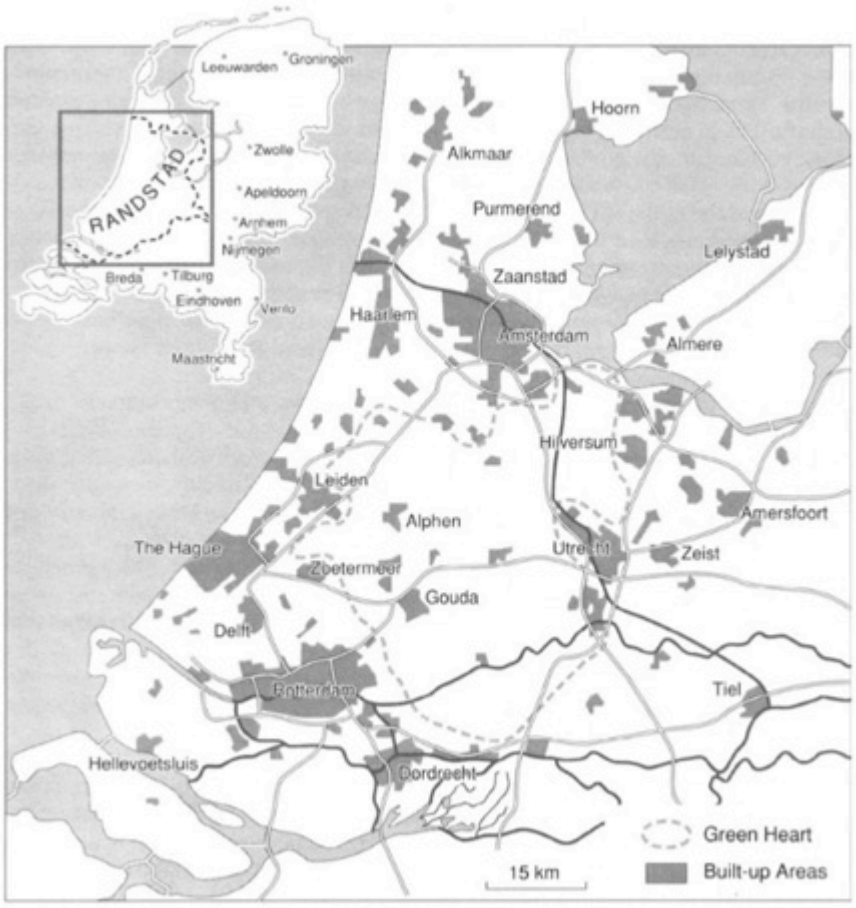


Figure 3.4: The Randstad Conurbation

Grey indicates urban population density, lighter areas are less densely populated areas. No density metrics are known, this is a diagram only to show the morphological spatial relationship between the urban areas only.

(Source: F.M. Dieleman and S. Musterd; The Restructuring of Randstad Holland; in The Randstad: A Research and Policy Laboratory, Springer 1992)

3.2.3 Patterns of Urbanisation within Conurbations of Peri-Urban Regions

Urbanisation, as a process, transforms land, over time; it is spatio-temporal. The urban-centres and cities within these conurbations undergo consistent structural change such as redevelopment and density caused by many drivers and pressures (See Figure 1.2). The functional and morphological changes to their urban-centres result in changes to the relationships with the surrounding landscape, most conspicuously on the edges between urban and rural landscapes – the peri-urban region (PUR). As urban areas have developed further away from their urban-centres, the spatial patterns imposed upon the landscape are notable. Two distinct patterns of urbanisation result - monocentric and polycentric.

The monocentric urbanisation pattern has been the model most widely used to analyse the spatial organisation of PUAs and their urban-centres. Building on the concept of hierarchical urban systems, Alonso (1964) and Mills (1972) described this monocentric city model based on density gradients and resource allocation within metropolitan areas. In recent decades, however, human development and the drivers of urbanisation have evolved to create new urbanisation patterns, particularly noticeable in the many small to medium sized city-regions of Europe (e.g. The Randstad – The Netherlands, Manchester/Liverpool Region - UK, Marseille Region - France) where multiple, smaller sub city-centres (sub-centres) have developed (Garreau, 1991). This pattern is multi-nucleated as opposed to mono-nucleated and is referred to as polycentric.

Monocentric urbanisation patterns exhibit continuous expanded growth around a single urban centre whereas polycentric urban regions are most often defined through their spatial structure and include various sub-centres (Anas et al., 1998) or multiple-nuclei structure (See Figure 3.5). Examples of classic

monocentric cities and urbanisation patterns include Paris and London. Here, urbanisation simply grows concentrically from the dominant central city centre or central core (See Figure 3.6) often creating what is referred to as 'Mega Regions'.

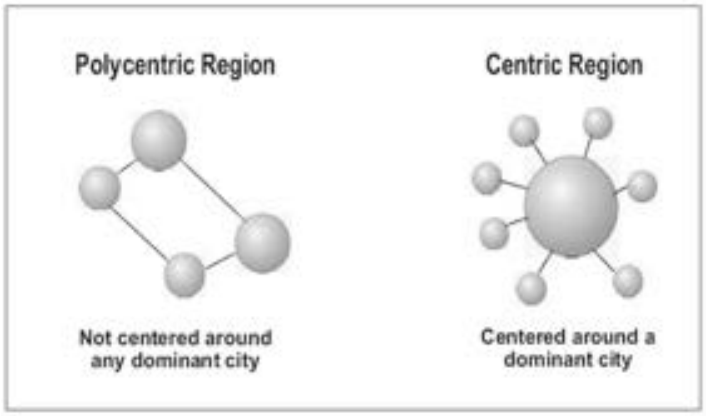


Figure 3.5: Monocentric and Polycentric Spatial Structure

(Source: Sinulingga, 2005)

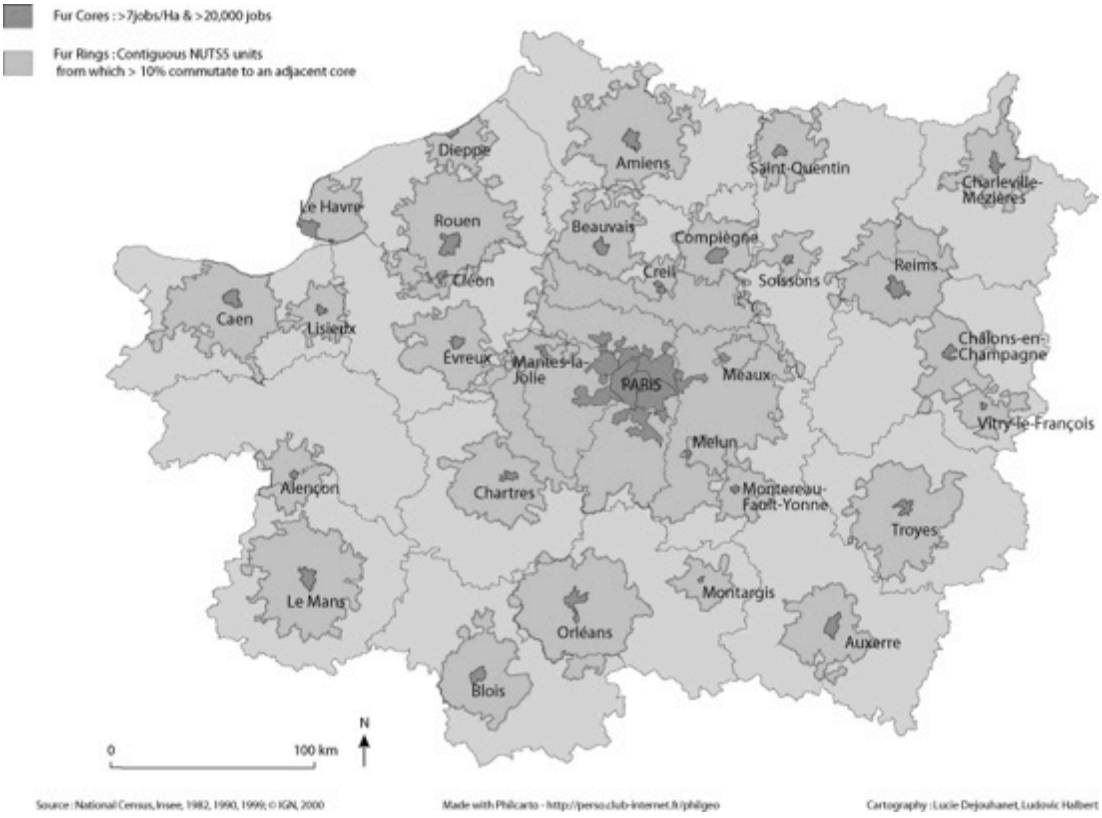


Figure 3.6: Monocentric Spatial Structure of Paris

Dark grey areas indicate areas >20,000 jobs. Lighter grey areas indicate >10% jobs which require commute to another space.

(Source: GaWC Research Bulletin 307, 2009)

Polycentric urban areas metamorphose spatially in two distinct patterns. First, as the central monocentric structure of large metropolitan regions grow outwards, often exhibiting sprawl, some urban areas dissolve, leaving behind more distinct sub-centres that have a polycentric form but are still within the larger conurbation of the central core city. The suburbs of Rouen, Reims and Orleans around Paris exemplify such polycentricity. In these examples, large cities are not born polycentric, they evolve to become so. In this regard, monocentric and polycentric urban areas are the same physical entity, just spatially changing over time.

Secondly, and more typical, is the development of multiple small to medium sized cities with no distinct central core or central city within an overall conurbation. Examples of classic polycentric cities and conurbations include the Randstad in the Netherlands, the Rhine-Ruhr in Germany, and Central Belgium (See Figure 3.7). This traditional polycentricity creates different urbanisation patterns than the first and shall be the focus of this research.

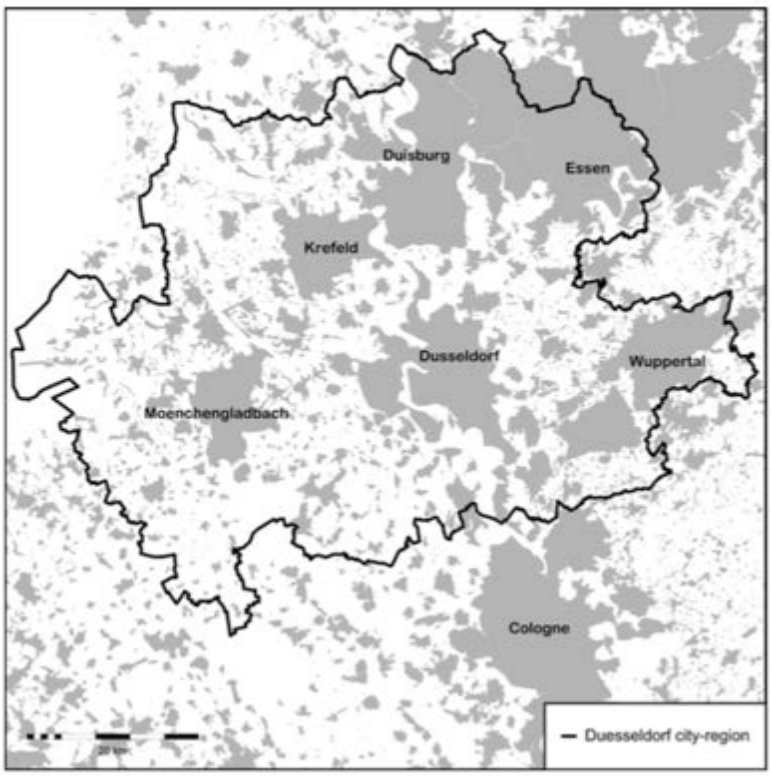


Figure 3.7: Polycentric Spatial Structure of the Rhine-Ruhr Region

Grey indicates urban population density, lighter areas are less densely populated areas. No density metrics are known, this is a diagram only to show the morphological spatial relationship between the urban areas only.

(Source: Information und Technik Nordrhein-Westfalen - IT.NRW, 2009)

3.2.4 Polycentric Urban Regions and Polycentric Urbanisation

Although most parts of the world, especially in developing countries (e.g. India, China, South America), will see significant urbanisation in emerging megacities and their larger metropolitan conurbations (Florida et al., 2008), the European region will continue to accommodate human development predominately through polycentric urbanisation (ESDP, EPSON, Europe 2020 - TA EU 2020 Implementation Report, 2011) within and among its metropolitan regions, a development arrangement which redistributes Europe's traditionally compact city forms. This section will answer the following questions:

- What is polycentrism, how is it defined, and how does it occur?
- How do polycentric urban areas differ from other urban areas?
- How does polycentric urbanisation affect the physical landscape?
- Can one measure polycentrism?

Both academia and public policy have put considerable efforts into better understanding the concepts of 'polycentrism' and 'polycentric development' and its associated impacts and benefits, yet these terms still remain unclear and their spatial manifestations ambiguous (e.g. Lambregts, 2009; Parr, 2008; Lin et al., 2013, Finka and Kluvankova, 2015). Polycentricity is often defined in terms of scale and thus considered at different spatial levels: inter-regional (e.g. Europe-wide); intra-regional (e.g. multiple interconnected urban centres such as the Ruhr-Rhine Region); or intra-urban (e.g. multiple centralities within a single urban area or conurbation such as London or Paris[5]).

Polycentrism, as a spatial planning concept (i.e. polycentric development), has become the preferred spatial form to accommodate urban growth and development in the Europe (ESDP, 2002). Polycentricity includes a range of labels such as multi-core metropolis (Hall, 1999); global city-regions (Scott, 2001); and polycentric urban regions (Kloosterman and Musterd, 2001; Hall and Pain; 2006; Parr, 2008). Overall, the concept of polycentricity is a principle of spatial organisation and refers to patterns of concentration and dispersal within the process of urbanisation.

Most literature focuses on the distinction between whether a region (or area of concern) is morphologically polycentric or functionally polycentric (See Figure 3.8). The elements of concern within these two concepts are the systems and elements present, such as the movement of goods, people and services within the physical form of the urban area.

[5] *As discussed, these areas are classically monocentric in morphology, but depending on scale and context, can be considered intra-urban polycentric.*

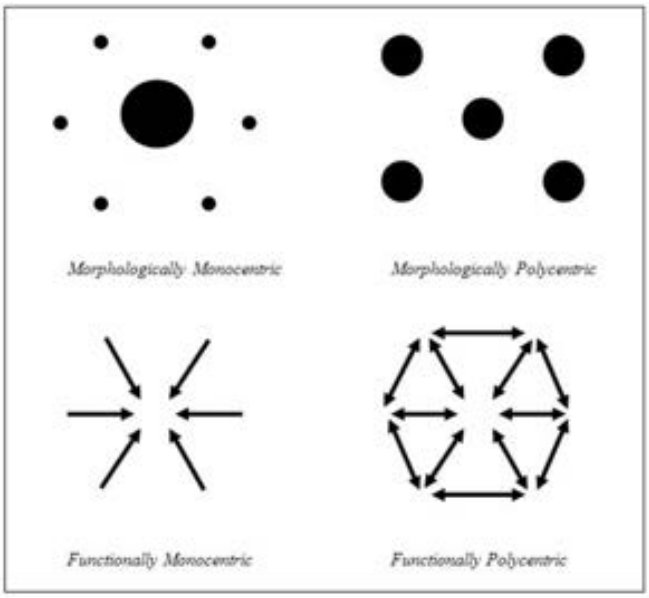


Figure 3.8: Morphological Centricity versus Functional Centricity

(Source: Polycentricity and the Multiplexity of Urban Networks. M.J. Burger, B. van der Knaap, R.S. Wal. GaWC Research Bulletin 273 - in European Planning Studies)

Morphological polycentricity relates to the distinct spatial relationships in and among urban components (e.g. population, employment, land use) and the resultant form of the region, considering multiple urban-centre sizes and distributions (Meijers and Berger, 2010), labelling these distributions as being polycentric or multi-nodal.

Functional polycentricity, on the other hand, moves beyond spatial relationships and views their connections, and the performance of these connections of such systems and elements to deliver the regions's intended services and also labels these more balanced relationships as being polycentric (De Goei et al., 2010; EPSON 1.1.1, 2004). To state this another way, functional polycentricity considers the balance in the distribution of functional linkages whereas morphological polycentricity considers the balance in the size of these functional linkage producing entities (i.e. forms or urban-centres).

Both functional and morphological polycentricity are interrelated. The morphological or spatial aspect of polycentricity focuses on the size and distribution of urban-centres across space. This dimension is often associated with the extent to which the landscape is characterised by a more even and balanced

development. The functional aspect of polycentricity focuses less on the internal characteristics (e.g. size, density) of the urban-centres and more on the way these urban-centres organise the region spatially by supplying the functions that shape the region's relationships. (De Goei et al., 2010).

Functional polycentricity describes the pattern of *functional interaction* between the urban-centres specific to the land-use development drivers and pressures. Whereas, functional polycentricity does not signify spatial or morphological polycentricity, morphological polycentricity does often include functional polycentrism. Many spatially monocentric (i.e. morphologically interdependent) urban regions function polycentrically (e.g. intra urban polycentric) (Burger, 2012) through various links and network structures (i.e. infrastructure) in the physical movement of goods, people and services.

Furthermore, functional polycentricity is an engineering-based, government-founded, and economic-focused (i.e. employment) criterion (ESDP, 1999; TAEU 2011). Nevertheless, the functional and spatial morphological approaches share the same basic principle: both characterise PURs as consisting of a group of urban-centres that are relatively equal in terms of their importance (Kloosterman and Lambregts, 2001; Meijers and Romein, 2003). The level of polycentrism varies with each country, region, scale, and urban centre context, as does the specific spatial distribution of the built-environment elements, yet are distinctly polycentric in physical character, which is the critical criterion in this research's analysis.

3.2.5 Polycentric Development and Polycentric Urbanisation

Three distinct yet parallel approaches towards clarifying the concept of polycentric urbanisation and polycentric development exist (Lambregts, 2009):

- Polycentric development as a planning strategy that can be applied at metropolitan, national and transnational scales (e.g. Albrecht's, 2001; Davoudi, 2003);
- Polycentric development as a distinctly spatial mechanism of functional hierarchies (Hall and Pain, 2006);
- Polycentric urbanisation as an outcome or physical configuration of this spatial mechanism.

It is this physical configuration - morphological polycentricity - that encompass the breadth of academic and public policy polycentric urbanisation literature (de Geyter, 2002). Harris and Ullman, two urban geographers, introduced the spatial concept of polycentric development in 1945.

It is the lack of hierarchy in both functional and morphological aspects that distinguishes the polycentric urbanisation patterns from monocentric ones. Importantly, it is this balanced distribution of the size and interaction to and among urban centres (i.e. their reciprocal relationship) that separates polycentric urban forms from 'multicentric' or 'multinuclear' forms within an urban area/system (Meijers et al., 2007; De Goei et al., 2010; Burger et al., 2011).

In a morphologically polycentric development pattern, there is no dominant centre and their multiple centres are relatively equal in terms of importance or hierarchy. In a functionally polycentric development pattern, the relationships between the urban-centres have no dominant centre or clear orientation (i.e. infrastructural outflow from the urban core only – the multiple centres are equally interrelated). In a morphologically monocentric development pattern, on the other hand, there is a distinct dominant centre or urban core, spatially and functionally, which all 'flows' pass through or are oriented towards (See Figure 3.11).

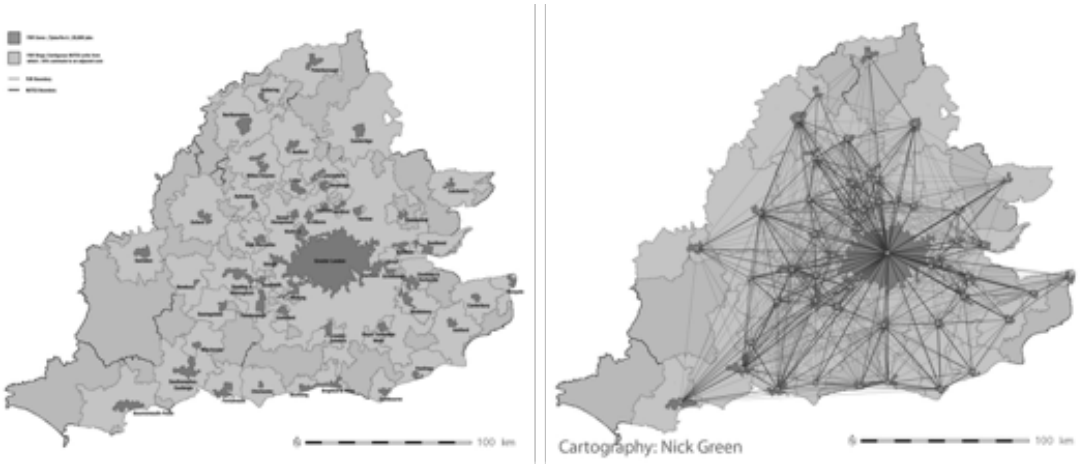


Figure 3.11: Morphological Monocentrism (L) and Functional Monocentrism (R) Diagrams - London

Grey indicates urban population density, lighter areas are less densely populated areas. No density metrics are known, this is a diagram only to show the morphological spatial relationship between the urban areas only. The lines of the Diagram on the R indicates commuting relationships.

(Source: L. Halbert and K. Pain. PAR-LON - Doing Business in Knowledge-Based Services in Paris and London: A Tale of One City? GaWC Research Bulletin 307)

Polycentrism has evolved as a spatial form for many reasons. Either, the mega-city has grown beyond its original, contained borders - expanding its monocentric form to many smaller and newer 'satellite cities' or urban conglomerations. Or, smaller cities have grown but never to a larger (mega) scale and, when viewed regionally, present a series of relatively evenly-populated and spatially-similar cities.

Although polycentric urbanisation has occurred out of physical necessity within Europe (e.g. population migration, resource dispersion), recent planning policies view polycentrism as a more efficient, economically viable, and even human-scaled urban spatial form. The European Spatial Development Perspective - ESDP (1999) sees polycentric development as a method to facilitate a more balanced, competitive growth. Shaw and Sykes (2005) note that metropolitan areas drive the economic development of Europe and planning strategies seek to combine the strengths of multiple urban-centres in order to be globally competitive.

The European Spatial Development Perspective (ESDP) and the European Union Ministers of Planning proposed a core policy objective of polycentricity in the European urban system in 1999 during a meeting in Potsdam, Netherlands (EC, 1999; Damsgaard et al., 2011). This policy promotes the development of alternative urban-centres outside of the existing central core and conurbations as exemplified in London and Paris.

3.2.5.1 Polycentric Urban Regions

The concept of a polycentric urban region (PolyUR) is usually distinguished from an agglomeration, which has multiple sub-centres within a single built up area (Parr, 2008). The basic idea of a PolyUR implies physically separate but inter-related urban-centres. It is often interpreted as a region with three or more distinct cities or towns in reasonable proximity and well-connected (i.e. morphologically and functionally polycentric), none of which is dominant (Dieleman and Faludi, 1998; Kloosterman and Musterd, 2001). Although the traditional urban region or city-region may also include a number of distinct urban-centres, these regions tend to build around one dominant core city; in a polycentric urban region this kind of dominance is much less pronounced (Parr, 2008).

A monocentric region views the relationship with other nodes (sub-centres) within a hierarchy and a one-way interaction, often between urban and rural regions. (See Figure 3.12 A). Alonso (1964) defines a monocentric region as nodal areas containing a principal centre and several surrounding subordinate or small centres within the principal's city 'market area'.

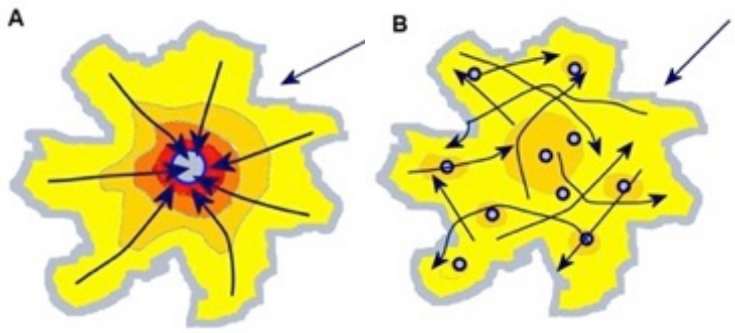


Figure 3.12: Urban Regions and their Spatial Development Patterns
A. Monocentric Urban Region – with Dominant City Centre
B. Polycentric Urban Region – no Dominant City Centre
(Source: Bertaud, A.; *Order without Design*, 2006-unpublished)

The literature provides differing means to define PolyURs on the basis of their key characteristics (Batty et al., 2003; Hall and Pain, 2006; Couch et al., 2007). However, PolyURs have three (3) easily recognised characteristics (Florida et al., 2008) :

- size of growth centre or cities;
- distance to each growth centre or city;
- city hierarchy within the region.

Kloosterman and Lambregts (2001) refer to PolyURs as an assemblage of historically distinct and both administratively and politically independent cities located in close proximity and well connected through infrastructure. Notably, this definition implies the future potential for (functional) integration through existing infrastructure. This is the specific spatial characteristic found within the Europe currently and the goal for EU policy – many clusters of medium-sized, close-by cities in which functional and morphological polycentricity can be readily achieved with proper conditions.

As best described by André Botequilha-Leitão (2012), *"polycentric development is a form of decentralised concentration of numerous small- and medium-size urban-centres, frequently (but not restricted to being) organised around a compact city centre, forming large urban agglomerations"*. In many of Europe's urban regions, the spatial conurbation is simply a polycentric-arranged agglomeration, in which functional infrastructure grew to create interconnected

city-centres and sub-centres, forming a singular urban area. Within PolyURs, these functionally and morphologically independent urban-centres or sub-centres (Anas et al. 1998) are sometimes referred to as 'edge-cities'[6] (Garreau, 1991). An important characteristic of these PolyURs is that the boundaries of the individual city-centre nodes are not readily recognisable and often overlap one another. In these regards, polycentrism exhibits characteristics of the term 'sprawl' and indeed some scholars reject the concept of polycentricity and just refer to polycentric urbanisation as sprawl (e.g. Brueckner and Fansler, 1983; Frey, 1999). For Ewing (2008), sprawl is just a matter of degree. From this perspective, the difference between diffused-development and multinucleated development is minor. *"At what number of centers polycentrism ceases and sprawl begins is not clear"* (Gordon et al., 1986, p. 662). Polycentric urbanisation is more efficient that sprawl, however (Haines, 1986), particularly in terms of infrastructure when metropolitan areas grow beyond a certain size threshold.

3.2.5.2 Polycentric Peri-Urban Regions

PolyURs exhibit similar characteristics to peri-urban regions (PURs). Traditional PURs are distinguished by a single-nuclei zone of influence (i.e. urban core) or a city-system along a radial pattern occurring from the city core to suburban to peri-urban to rural areas (e.g. Cermasi and Psarra, 2013), often along transportation or other infrastructure systems (See Figure 3.12-A). Polycentric peri-urban regions (PolyPURs) do exhibit similar characteristics, but also have a high concentration of rural areas (PLUREL, 2013), unlike traditional PolyURs and PURs (e.g. Allen, 2003; Lambert, 2011) which have a continuous, diffused human land-use development pattern of grey infrastructure very similar to 'decentralised sprawl' with mixed land uses (PLUREL, 2013).

The PolyPUR spatial structure is most notable when reflecting upon the development pattern of polycentric regions and their various urban-centres that illustrate, spatially, significant rural or green spaces between these urban-centres (i.e. small- and medium-size city-centres) (Hall and Pain, 2006) often purposefully

[6] Garreau defined this concept primarily through commuter flow and economic activities, not spatial relationships.

spatially planned such as the Netherland Green Heart (Figure 3.13) and the Copenhagen Fingers (Figure 3.14).

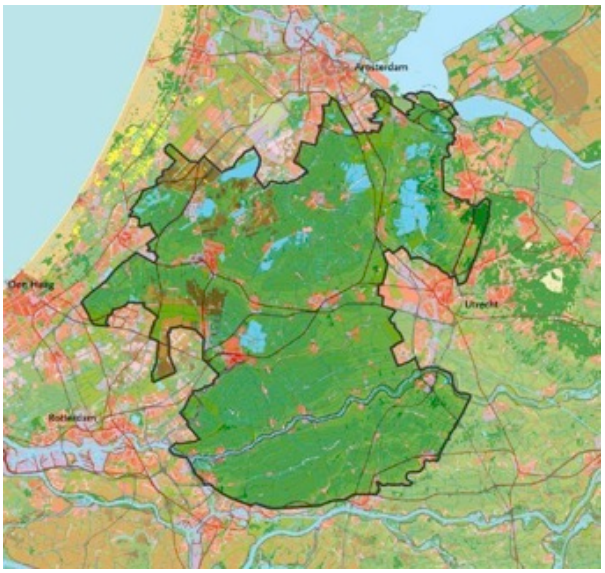


Figure 3.13: The Green Heart within the Dutch Randstad



Figure 3.14: The Copenhagen Finger Plan
(Source: Retrieved June 2013 from:
http://www.groenehartholland.nl/groenehart/nieuws/woningen/bericht/?p=46*)*

Differentiating between PolyURs and PolyPURS proves subtle yet important. Both are PUAs; both are associated with human development occurring from the urban core to the rural areas; both are regions in the process of becoming more urban. Both are transitional zones; 'hybrid landscapes' of both urban and

rural characteristics as exemplified along the rural-urban spectrum (See Figure 3.2). Importantly, both are socio-ecological landscapes. The PUR, including PolyUR is often referred to as the urban fringe, suburban edge, rural-urban zone, rurban space, exurban area, and many others. It is the *type of development patterns* that occur within these two regions that make them distinct, however: PolyPURs are affected by urbanisation on all sides.

It is not only the functional morphology of these PUAs that make them ideal for urbanisation (i.e. urban expansion from the city-centre), but also the spatial morphology present within a pre-existing agglomeration of infrastructure. PolyPURs have a particular aspect not shared by urban and PURs/PolyURs - open spaces and diverse green spaces of various sizes and shapes among and between their (morphologically polycentric) urban sub-centres (See Figure 3.15). In this regards, Poly PURS are distinctly multifunctional 'hotspots' (Hansen, R. and Pauleit, S., 2014) where the diversity of landscape structures, processes and functions provide for diverse benefits to both humans and nature.

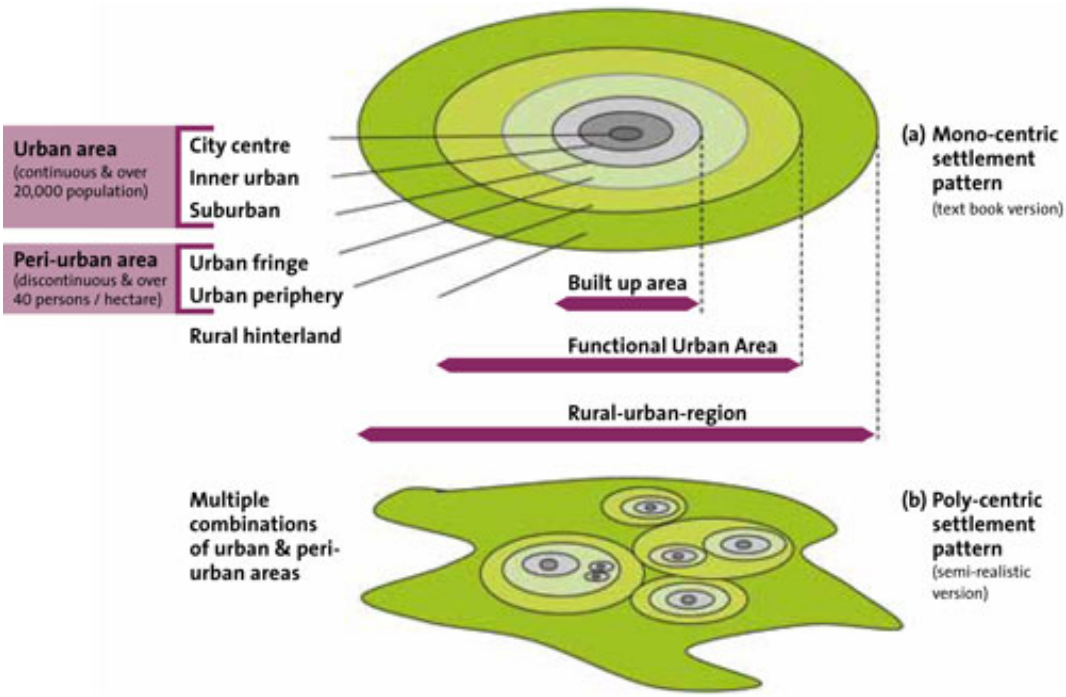


Figure 3.15: Polycentric Urban Region and Peri-Urban Areas (Source: PLUREL D3.3.8, 2011)

Traditional PUAs exist on the edge of agglomerations, such as London or Paris. PolyPURs often have continuous PUAs on the edges of their individual conurbations found around and among the multiple urban-centres within a morphologically PUR. Put another way, a region is considered morphologically polycentric when there are multiple cities that are closely located to one another, but in a morphologically peri-urban polycentric region, these cities are separated by rural-based land uses and landscapes.

The Randstad in the Netherlands is the classic example of European polycentric development, exhibiting PolyPURs due to its four primary cities of between 300K-700K people, spatially 'close' to one another, and with the 'Green Heart' rural lands between them. The Randstad region includes the cities of The Hague, Utretch, Rotterdam and Amsterdam, and about six smaller ones related through their suburban extensions. Functionally, all of these cities are well connected by rail. The Randstad, or 'Ring City', does not share the physical characteristics of typical European metropolises, such as Paris or London, but rather include these four urban conurbations surrounding a minimally populated and developed green area, the 'Green Heart of the Netherlands' or the 'Groene Hart' (See Figure 3.13).

3.2.5.3 Measuring Morphological Polycentricity and Polycentrism

Polycentricity is currently evaluated upon a small set of functional indicators and, separately, morphological or spatial indicators (Champion, 2012; Stiles et al., 2014). A set of integrated or biophysical and socio-cultural indicators have not yet been developed or tested.

In its attempt to measure polycentricity, ESPON 1.1.1 identified two complementary aspects of polycentricity. The first aspect is urban morphology, which can be described by the hierarchy of cities in an urban agglomeration. The second aspect is a functional or relational one, corresponding to the analysis of the functional profiles of cities and to the flows of various infrastructures (i.e. transport, communications and co-operation) between them. This conceptual

region is often referred to as a metropolitan statistical area (MSA)[7] (Hall, 2009). From this perspective, polycentricity is based on morphological proximity. Morphological polycentricity can perhaps be best comprehended and measured when viewed in the context of the larger urban area or region and the distinct characteristics that separate it from other types of urban regions (See Section 3.2.5.2 above).

Regardless of a PolyPURs spatial form (i.e. morphological polycentricity), and its distribution of linkages and directional flow patterns (i.e. functional polycentricity), the characteristics and measures used to analyse them change constantly, and thus data collection, as well as valid measurement, is difficult and unresolved (Burger, 2012). Though the concept of scale is not assured; a PolyPURs may be polycentric at one scale may be monocentric when examined at another scale (Davoudi, 2003; Hall and Pain, 2006; Taylor et al., 2008). Although various metrics exist for measuring a polycentric region's functionality, particularly as exhibited through EPSON's Functional Urban Areas (FUA) (e.g. commuting catchment area, network density, centrality, system flows, etc.), this research focuses on morphological polycentricity.

In Europe, EPSON (2004) measured polycentricity through the spatial concentration levels of settlement patterns within CORINNE Land Cover data. Utilising the indicator of proximity, PUSH (Potential Urban Strategic Horizons) determined polycentric integrated areas (PIA) based on spatial concentration levels (See Figure 3.16). The Study Programme in European Spatial Planning (ESDP, 1999) created typologies along the rural–urban settlement pattern.

[7] The term was first used in official nomenclature in 1949 as the standard metropolitan area (SMA). In 1959, the term was renamed the standard metropolitan statistical area (SMSA), in 1983, the metropolitan statistical area (MSA), in 1990, the metropolitan area (MA) and lastly, in 2000, the core based statistical area (CBSA). Although slight variations have occurred in defining the terms, they are basically variants of the same concept (Hall, 2009).

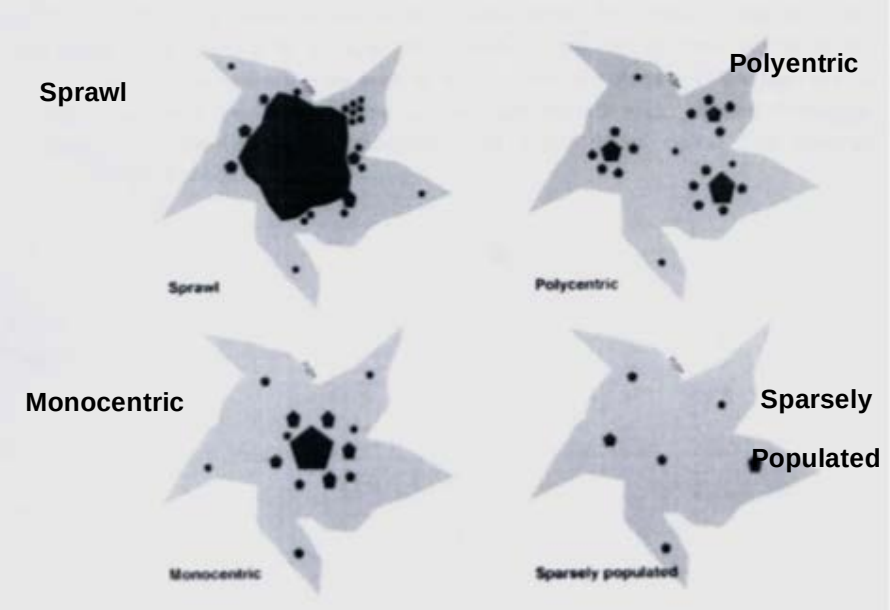


Figure 3.16: Morphological Typologies of Urban Regions:

Monocentric, Polycentric, Sprawl and Sparsely Populated (rural)

Grey/Black indicates urban population density, lighter areas are less densely populated areas. No density metrics are known, this is a diagram only to show the morphological spatial relationship between the urban areas only.

(Source: ESPON 1.1.1; 2004, Fig. 5.4, p. 151)

Additionally, PLUREL (2011) distinguished regional spatial classes (NUTS 3 level) in Europe's landscape through the lens of urbanisation within its settlement morphology. The four classes are described as a morphology type:

1. Monocentric -

Regions with core city area without notable peri-urban sub-centres, three sub-types by core city size: very large (+metropolitan), large, medium;

2. Urban polycentric -

Regions with core city (or cities) and peri-urban sub-centres;

3. Dispersed polycentric -

Regions with several (medium-sized) peri-urban centres;

4. Rural -

Rural regions without notable centres but dispersed smaller settlements.

Other spatial measures of polycentric urbanisation also exist. Gradient analysis (McDonnell and Pickett, 1990) is common within morphological studies, particularly spatio-temporal analysis, but these often focus solely on ecological patterns and processes (Andersson et al., 2015) often through GIS and are not well suited to urban or urbanising contexts of the SELs found within PolyPURs.

In summary, contemporary theory, definition and measurement regarding polycentrism and polycentric urbanisation are unclear and imprecise. Consistent scalar applicability is lacking (i.e. cities, regions, etc.) (Kloosterman and Musterd, 2001). Additionally, academic literature refutes the functional efficacy (Vanolo, 2010) and equitable spatial distribution of urbanisation within polycentrism's land-use pattern (Vandermotten et al., 2008). Despite this uncertainty, European policy continues to adhere to the polycentric spatial approach and the foreseeable future will see continued polycentric development patterns in the Europe.

Spatially, polycentrism is viewed as a countermeasure to the failings of monocentric mega-cities in Europe and other countries (e.g. urban sprawl, decreased human health, low quality of life, ecological degradation, resource access and distribution, management difficulties, etc.) (e.g. Botequilha-Leitão, 2012; Moir, Moonen and Clark, 2014; Oueslati et al., 2015). As with most urban expansion, however, the non-urbanised landscape (e.g. rural lands, agriculture, forests/woodlands, open spaces, green spaces) is affected; polycentric urbanisation entails land cover change and landscape fragmentation (Pauleit et al., 2005; Grigonis, 2013). But it is the spatial characteristics of PolyPUR landscape fragmentation that is unique to other forms of landscape fragmentation. PolyPUR fragmentation occurs *within and between* the new nodes or conurbations, or the PUAs, within a PolyUR primarily due to the transportation infrastructural links required for functional polycentricity. And despite the features that make polycentrism favourable (e.g. functional based such as increased services, improved public health access, integrated transportation and infrastructure), landscape fragmentation is an inadvertent result (Bawa-Cavia, 2010; Jenks et al., 2013; PLUREL, 2013) that requires further analysis.

3.3 Landscape Fragmentation

In Europe, an important physical change to the landscape through the urbanisation process that has attracted significant interest, both from the scientific community and, more recently, from the broader population, is landscape fragmentation. Landscape fragmentation has come to the forefront because it affects both ecological systems and human activities. From landscape ecology to the cognitive sciences, multiple disciplines have dealt with the concept and measurement of landscape fragmentation and its effects on ecological habitats and human societies (see, for example: Bogaert et al., 2005, Fahrig, 2003, Haila, 2002, Hanski, 2005, Jongman, 2002, Ode et al., 2008, Purcell and Lamb, 1998, Saunders et al., 1991 and Taylor, 2000).

In studying the relationship between landscape, urbanisation, polycentricity, landscape fragmentation, and human wellbeing, important questions must be answered:

- How is fragmentation and landscape fragmentation defined?
- What are the drivers or mechanisms of landscape fragmentation?
- What impacts are associated with landscape fragmentation?
- How is landscape fragmentation characterised and measured?

Fragmentation is defined primarily in literature through two aspects: as a process or as a state. The process of fragmentation is 'the action of breaking or separating into fragments' or 'the separation into parts which form new individual units' (Brown, 1993, p 1018). With a focus on spatial planning, fragmentation is a spatial state (i.e. fragmented spaces) ***and*** the active processes that result in that state (Jenks and Kozak, 2008).

As a spatial phenomenon, land fragmentation, can be defined as "*the breaking up of a habitat, ecosystem or land-use type into smaller parcels*" (Forman, 1995). As a concept, the study of landscape fragmentation is based within the natural sciences, particularly landscape ecology, and therefore most definitions are ecologically founded (e.g. Forman, 1995, Rutledge, 2003) with associated spatial-based metrics often enacted through GIS.

Building from landscape ecological definitions and concepts as discussed in Chapter 2, landscapes are composed of a mosaic of 'patches' as the basic elements

or units that make up a landscape (Forman, 1995) creating a matrix (Kotliar and Wiens, 1990). From an ecological perspective, patches (Forman, 1981; Forman and Godron, 1986) represent relatively discrete areas (spatial domain) or periods (temporal domain) of relatively homogeneous environmental conditions where the patch boundaries are distinguished by discontinuities in environmental characteristics (e.g. land cover or land use – see Section 3.2) from their adjacent landscapes or patches, often in relevance to the organism or phenomenon under consideration. Simply, a patch of landscape is an area of land exhibiting an homogeneous pattern relative to other areas, given the grain or scale of the landscape data. These patches therefore have different characteristics or classes. The number of classes (i.e. characteristics) that the landscape is divided into is relative to the study in question and the scale of the data.

Ecologically, fragmentation is the division of contiguous ecosystems into patches. As mentioned, a patch is an area with relatively homogeneous conditions compared with other patches (Forman, 1995). Landscape fragmentation involves the substitution of contiguous natural land covers or habitats, most often by anthropogenic types, resulting in disconnected and isolated patches of 'nature' (Bogaert et al., 2005) often referred to as open space or green space (See Section 3.4). Landscape fragmentation can be explained through the spatial and temporal dynamics of land use change (Fahrig, 2003). In the discourse of the human development process and urbanisation, the concept of landscape fragmentation is the result of transforming large areas or spaces into smaller, more isolated spaces (i.e. patches) that lack physical connectivity to other spaces (i.e. patches) within the landscape (i.e. mosaic and matrix) (See Figure 3.17). Technically, landscape fragmentation is an anthropogenic process that consists of breaking up a continuous habitat, land use type, biota, or ecosystem (Carvalho et al., 2009). In this regard, landscape fragmentation is the breaking up of larger areas of natural land cover into smaller, more isolated patches independent of a change in the total area of natural land cover.

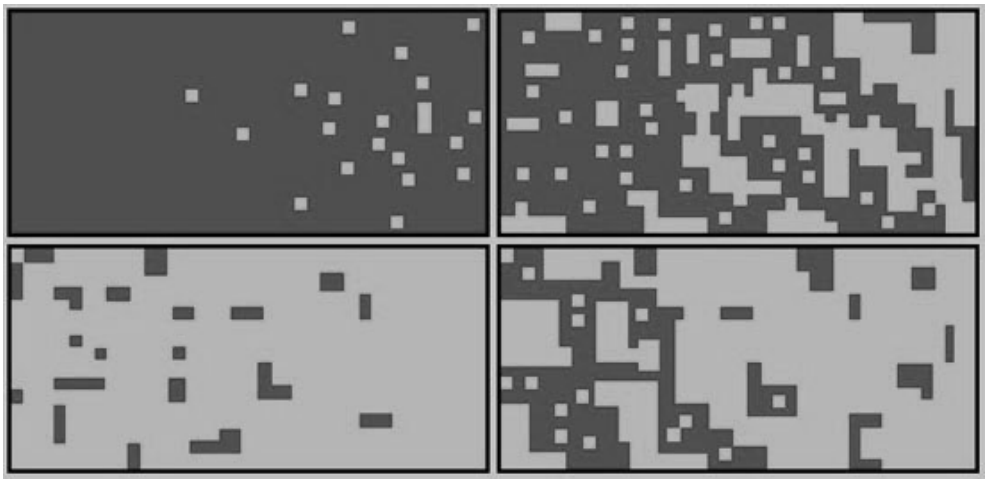


Figure 3.17: Process of landscape fragmentation

Fragmentation can be summarised through spatio-temporal change. Clockwise, from the upper left panel: (a) perforation (initial small openings), (b) dissection (larger intrusions of change, often along physical features such as infrastructure), (c) dissipation (spread and coalescing of alteration), and eventually, (d) shrinkage (reduction of patch size), and attrition (loss of patches).

(Source: Nature Education, 2010. Courtesy of Michigan Forests Forever Teachers Guide)

Fragmentation is a multi-disciplinary concept with many definitions within different academic fields and contexts. This research will define landscape fragmentation as an outcome of the human-induced landscape transformation or landscape change process. Here, natural land covers are replaced by anthropogenic landscape typologies and transform the natural landscape pattern into disparate, disconnected and isolated patches (Bogaert et al., 2005).

Mechanisms causing fragmentation in the PUL can be natural (e.g. fire, landslides, floods, etc.) but are most commonly caused by human impacts (Franklin et al., 2002) (e.g. logging, agriculture, urbanisation, etc.). The causes of landscape fragmentation are diverse and numerous and include inadequate environmental or planning policy leading to land mismanagement (e.g. agricultural) and inappropriate land use (Puildo and Bocco, 2014), as well as changing land ownership or insecure tenure. Construction of transport infrastructure, and modifications to the landscape for urban development such as housing are the two main mechanisms causing landscape fragmentation in Europe (e.g. Saunders et al., 1991; Zhu et al., 2006; Hawbaker et al., 2006; Jaeger et al.,

2007; Trocmé et al. 2002).

Fragmentation, in the spatial planning disciplines and natural sciences, is often correlated with the terms land cover and land use. Landscape fragmentation affects spatial arrangement and the physical characteristics of the landscape – its spatial structure. Landscape fragmentation is not only caused by less physical connection (i.e. through barriers and other grey infrastructure), but also an overall lessening in specific landscape quantity (i.e. spatially separated fragments as other lands uses and land change occurs).

Landscape fragmentation, much like urbanisation, is most noticeable in the peri-urban and rural landscape where the pressures on the agricultural and forestry-based landscapes as well as transportation impacts such as roads and infrastructure create significant landscape fragmentation.

3.3.1 Impacts of Landscape Fragmentation

Landscape fragmentation affects both human quality of life (e.g. Deller et al., 2001; Rickenbach and Gobster, 2003; Sudhira, Ramachandra and Jagadish, 2004), and the quantity and quality of the biophysical or natural landscape, in the latter case particularly by disrupting the functionality of the ecosystem (Harris, 1984; Forman and Godron, 1986). An extensive body of literature has explored the ecological effects of landscape fragmentation on the biophysical landscape, its ecosystems, and the associated habitats (e.g. Vogelmann, 1995; Fuller, 2001; Cayuela et al., 2006; Echeverrıa et al., 2007; Altamirano et al., 2007; Mitchell et al., 2015). Four notable biophysical impacts of landscape fragmentation merit brief discussion within the context of PPURs and PULs:

1. Ecological Integrity;
2. Resilience;
3. Biodiversity;
4. Ecosystem Services.

Ecological Integrity

As previously noted, the landscape may be defined by its function or processes (See Section 2.3). Overall, as landscape fragmentation occurs, and urban land cover and anthropocentric land uses increase, semi-natural and natural areas

such as woodlands and agricultural fields decrease. Importantly, the ecological quality of these landscape types decrease. As the landscape's structure changes, so does its overall integrity.

Ecological integrity has recently taken on a multi-disciplinary meaning (e.g. social integrity, natural integrity per Neimanis et al., 2012; Mueller, 2009), often due to the widening of the concepts included within ecosystems. For the purpose of this research, however, ecological integrity will refer solely to biophysical, structural and functional aspects within the landscape and its green spaces and green structures as discussed by Karr (1992).

Ecological integrity refers to a particular landscape's or ecosystem's completeness, and its ability to maintain its function under varying circumstances (Karr and Dudley, 1981; Barkmann and Windhorst, 2000; Lambin, 2001). An ecological system has integrity when its dominant ecological characteristics (e.g., elements of composition, structure, function, and ecological processes) occur within their natural ranges of variation and can withstand and recover from most perturbations imposed by natural environmental dynamics or human disruptions. This concept is referred to as resilience (Pardini et al., 2010) in the natural sciences disciplines. This state of low ecological integrity is often regarded as one of reduced ecological resilience (Alberti, 2005).

Resilience

Ecological resilience, first defined by Holling (1973), refers to the ability of an ecosystem system to undergo change and reorganisation while maintaining its fundamental functions, processes, and structures (Gunderson, 2000, Walker and Salt, 2006). Often simplified as a hardiness to vulnerabilities (Hessburg et al., 1999) or disturbances, resilience is negatively impacted by landscape fragmentation.

Resilience is often reduced through the spatial and structural changes in the landscape, particularly when urban or anthropocentric elements are interspersed, as in PULs (e.g. Walker and Salt, 2006; Schewenius et al., 2014).

Biodiversity

A significant impact to the landscape through landscape fragmentation is the

concept of *biodiversity* (Fahrig, 2003). Biodiversity – or biological diversity - is an important component of ecological integrity and resilience (Schulze and Mooney, 1993; Chapin et al., 2000; Naeem, 2002). Recent research has identified that biodiversity benefits both humans and nature simultaneously (e.g. Norris, 2012; Harrison et al., 2014*;* Sandafer et al., 2015) primarily through the concept of ecosystem services.

Ecosystem Services

Fragmented landscapes and their associated remaining patches of naturalistic features affect both humans and the biophysical landscape through the concept of ecosystem services discussed in detail within Section 4.4.1. These impacts include changes in the quantity and quality of the various elements in the physical landscape (e.g. soil, water, plants, animals, etc.) and their consequent ability to support the demands placed on them (i.e. environmental functioning and their ability to support human and non-human life) to maintain human welfare.

Landscape Fragmentation and Connectivity

Connectivity is a broad term, and refers to the characteristics of the landscape that affect the movement of organisms and of natural processes. It is usually interpreted with respect to species movement, but has wider implications, and is relevant to ecosystem functioning as a whole and its resilience (Latham et al., 2013).

In simple terms, connectivity can be thought of as the inverse of fragmentation, and thus actions to reverse or mitigate the effects of fragmentation will improve connectivity. However, though physical connectedness does improve functional connectivity between patches, it will not fully reverse the impacts of landscape fragmentation. Spatial planning approaches such as green infrastructure focus on connectivity and linear corridors while not fully addressing the complex and multifarious impacts of landscape fragmentation (Mazza et al., 2011).

Isolation occurs as a result of fragmentation and refers to reduced physical connectivity and increased distance among and between individual patches resulting in limited movement of organisms (i.e. permeability). This can affect many ecological processes across different spatial and temporal scales (e.g.

foraging, roosting, dispersal, genetic exchange, migration, pollination, as well as water and air cleansing).

Landscape Fragmentation and Edge Effects

Edge Effect

Various ecological models exist to provide an understanding of landscape fragmentation such as Island Biogeography Theory (IBT) (MacArthur and Wilson, 1963) and edge effect (Thomas et al., 1979). Edge effect is an ecological concept that refers to changes in the landscape structure at the intersection of two or more landscape typologies and often leads to reduced ecological integrity and resilience. Landscape fragmentation causes patches to become smaller and as their edge-to-area ratio increases, a higher proportion of these patches (e.g. habitat) become exposed to external factors. Additionally, the area of study contains increased total number of edges, edge length, and total number of smaller edges.

Edge effects are diverse physical and biological phenomena associated with the abrupt, artificial boundaries of landscape fragments. These occurrences include changes or disturbances to the structure, composition, and function of vegetation edges or fragmented margins (Chen et al., 1992; Ranney et al., 1981; Lovejoy et al., 1986). In forests, these fragmented, smaller interiors or cores are more susceptible to IBT's impacts as the edges served as a buffer to invasive species (Buechner, 1987), ecological degradation (Nascimento et al., 2006), and other phenomena (See Hopkins, 2013 for an thorough review and examples of edge effect impacts).

Edge effect is a common occurrence in PULs (Hardt et al., 2013) where anthropogenic modifications to the landscape such as road and infrastructure construction, residential housing, and other human development practices exist. The edge-effect impacts from human-induced modifications vary per spatio-temporal context (Tscharntke et al., 2012) and include variables such as landscape conditions, age and age of impact, matrix type, influence of pollution/soil/water, and type of anthropogenic interference.

Limitations exist within PUL research regarding edge effect caused through landcape fragmentation. Most literature focuses on forested landscapes

(e.g. Wuyts et al., 2008) and no clear metric for the distance of fragmentation/edge-effect impact exists (i.e. the penetration depth: 20m vs. 150m) (Spangenberg and Kölling, 2004). Further limiting effective study, Ries, Fletcher, Battin, and Sisk (2004) note that many researchers have failed to constructively comprehend how the surrounding landscape contributes to the formation and impact of edges. Studies have also produced varying edge contrast measures (i.e. a measure of the difference in structure, function or composition between the forest and the adjacent land use (Cadenasso et al. 2003). The cumulative effect of edges is also not well understood (Fletcher, 2005). Nor are the impacts on adjacent landscape patches or the natural spaces (i.e. green space), though theoretical and empirical evidence suggests that effects may extend well beyond forest boundaries (e.g. Ries et al., 2004).

Edge effects are both direct and indirect, and the interconnected variables found within complex PURs do not elicit clear patterns (Forman, 1995). Thus, analysing and defining the extent and intensity of edge effects in landscapes under different anthropogenic pressures is not an empirical science.

However, not all impacts of landscape fragmentation particularly through the urbanisation process are ecologically negative. Small patches serve ecological functions and processes as well, such as specific habitat niches (Turner and Corlett, 1996). Some species prefer and thrive in fragmented and more-edged landscapes such as farmland birds (Söderström and Pärt, 2000) often exhibiting increased biodiversity. Edges have proven to be niches for species richness (e.g. Ewers and Didham, 2006). Ecological concepts of connectivity includes both structural (physical arrangement) and functional (processes such as species movement) (Baguette et al., 2013). Theories of connectivity include consideration of representations of connectivity through ‘corridors’ and ‘linkages’ and continuous representations of connectivity. Furthermore, the interrelated factors that constitute these phenomena are hard to isolate and objectively determine (e.g. Pereira and Daily, 2006). Though corridors can conduct the movement of disease and pathogens between landscape fragments, which would

not have been present without interconnection, corridors also serve to improve many ecological processes within and among habitat patches.

Summary of the Impacts of Landscape Fragmentation

Although most landscape fragmentation impacts can be quantified through ecosystem service's biophysical processes, such as reduced air and water quality, flooding mitigation, soil regeneration and biodiversity (e.g. Alberti, 2005), the impacts on humans and society are often difficult to quantify and qualify (MEA, 2000). Landscape fragmentation produces societal and economic impacts, such as on household mobility, segregation, changing economic environments, modified agricultural activities and transportation patterns (Hall, 1998). These human-focused effects are exemplified in the peri-urban, polycentric landscape through additional roads, tram, rail and bridge construction, as well as housing and private sector developments. These anthropocentric impacts may be positive or negative in regards to humans. Negative results include economic displacement in respect to homes and jobs; positive benefits include enabling access to services such as hospitals, shopping and leisure activities, as well as reducing poverty and increasing safety. Fragmented PURs also provide more and more diverse interaction opportunities with green spaces.

This section has provided a brief overview of the effects of fragmentation on the biophysical landscape. As discussed, ecological integrity, resilience and biodiversity are often reduced through the spatial and structural changes in the landscape, particularly when urban or anthropocentric elements are interspersed, thereby creating landscape fragmentation and spatial heterogeneity within PULs (e.g. de Groot, 1992; Walker and Salt, 2006; Adams, 2009; EEA, 2010; Pasimeni et al., 2012). This physical change to the landscape ultimately affects humans in varied ways and is discussed in detail within the next Chapter.

3.3.2 Characteristics of Landscape Fragmentation

Landscape ecology draws upon the scientific foundations of the physical and biological sciences in order to contribute to the understanding of fragmented landscapes - to understandings of their structure, of interactions among the elements of the landscape and of changes associated with natural events and

human interventions.

Landscape fragmentation changes the PULs appearance (Yang, 2005; Di Giulio et al., 2009). Specifically, the literature suggests that it elicits three distinct yet interconnected spatial characteristics upon the landscape (Fahrig, 2003; Forman and Godron, 1981; Carvalho et al., 2009):

- Increase in spatial heterogeneity (i.e. interspersion);
- Increase in edge conditions (i.e. quantity/quality of edges);
- Increase in diversity (i.e. area characteristics).

Spatial Heterogeneity within Fragmented Landscapes

Spatial heterogeneity is a standard characteristic of landscape fragmentation (e.g. McGarigal and Cushman, 2002). Building on the simplest definition of landscape fragmentation as *"the breaking up of a habitat, ecosystem or land-use type into smaller parcels"* (Forman, 1995), spatial heterogeneity includes physical spaces of mixed concentrations and of multiple sizes and shapes, and encompasses land covers and/or land uses. Spatial heterogeneity can be visualised both vertically and horizontally and is often discussed as an urban growth pattern within the landscape. Whereas landscape fragmentation often implies rural lands fragmented by urban land uses, spatial heterogeneity is a more comprehensive measure of physical characteristics that may have both natural and human sources (Alberti, 2005).

Edge Conditions within Fragmented Landscapes

The landscape edge's zone of transition (Forman, 1995) is often abrupt at the rural-urban edge. As such, edges are a structural component of the peri-urban landscape. Landscape fragmentation increases not only the number of patches but the overall number of edges (Collinge, 2009) (i.e. total length within an area of analysis). Additionally, regarding fragmentation of vegetation structure - edge density is affected, overall vegetation height and species composition, and type of edge (i.e. natural vs. human made) (See Figure 3.18).



Figure 3.18: Landscape fragmentation affects edge conditions.

(Source: Benjamin Pennington, 1000 Friends of Florida)

Landscape fragmentation allows the influences from adjacent patches or parcels to affect landscapes, and 'edge effects', such as noise, shading, light conditions are altered.

Diversity within Fragmented Landscapes

Landscape fragmentation creates more patches but, overall, these patches are of a smaller average size within the area of analysis (Rutledge, 2003), often creating isolated remnants (Augustine et al., 1998). Landscape fragmentation creates a more diverse set of physical patch characteristics, including shape, size, edge, and distance to nearest patch, among others. Diversity within fragmented landscapes is also expressed in the qualities of the patches. These include diversity of vegetation structure and other biophysical characteristics such as openness/closure, level of greenness, connectivity, coherence, etc.

Overall, these three structural characteristics serve as straightforward, physical and spatial characteristics to identify and analyse landscape fragmentation, often specific to those smaller patches or naturalistic open and green spaces present.

3.4 Green Space and Green Structure

In this context of urbanisation within SELs such as PUAs and PolyPURs, landscape fragmentation creates larger, more connected, anthropic land uses and land covers whilst creating smaller, less connected biophysical or natural spaces. It is these fragmented green spaces and green structures (GS) that are the focus of this research and raises important questions:

- What is green space and how is it defined?
- How are green space and green structure interrelated in the context of this research?
- What is the current state of green spaces and green structures within a polycentric, fragmented, peri-urban, interstitial context?
- How are green spaces and green structures categorised?

The goal for this section is to develop an operational definition of green space and green structure. This section will briefly review the concepts and definitions of green spaces and green structures through a distinct spatial and physical viewpoint in the context of the PUL.

GS is often used in a similar context when referring to 'nature' (see Section 2.3), and both terms are difficult to define (e.g. Macnaghten and Urry, 1998), particularly as both are influenced by cultural perceptions (Vining et al., 2008). Although the literature provides both 'green space' and 'greenspace' as similar concepts, this research shall utilise the term 'green space'.

Open Space and Green Space

Though the terms open space and GS have been used interchangeably, there are distinct differences that must be recognised (Swanwick et al., 2003). In the spatial planning disciplines, open space is perhaps the most common term for the landscape. Open space occurs in urban conditions (i.e. cities) as well as the larger biophysical landscape. In Europe, open space is often considered to be the space between buildings and is often related to public space such as squares and plazas rather than the biophysical or naturalistic aspects of the landscape. Ward Thompson (2002) notes open spaces are indeterminate spaces. In the UK, open space is defined comprehensively (Town and Country Planning Act, 1990; National Planning Policy Framework, 2012).

Definitions of GS vary, and, much like open space, is land that is partly or completely covered with grass, trees, shrubs, dirt, or other vegetation (Bratman et al., 2012; EPA, 2012). GS is commonly defined as natural or semi-natural spaces (UK Forestry Commission, 2007). GS often serve agricultural, recreational and ecological purposes (e.g. reserves, wetlands, wildlife sanctuaries) but are not just

within the ‘natural environment’: they may include cemeteries, trailways, playgrounds, parks, recreational facilities, gardens, plazas, greenways, farmlands, forests, nature preserves, woodlands, river banks, vacant lots, etc. (DTLR, 2002; Swanwick et al., 2003; Atwell et al., 2005; CABE, 2006; Bell, 2007; UK Forestry Commission, 2007; Natural England, 2008; Greenspace Scotland, 2011), as well as blue spaces such as lakes or rivers and their adjacent greenery. Andrew Taylor at the University of Helsinki noted, however, that *“no universal definition of green space exists”,* and a lack of a clear definition further leads to confusion and difficulty in conducting and comparing research (Kit Campbell Associates, 2001). Open space, as well as green space, as mentioned previously, can be public or privately owned. In summary, this research concludes that most, if not all, green space is open space but not all open space is green space.

Urban Green Space

Green spaces can be found in urban conditions and cities at many varied scales, mostly as parks, avenues, gardens, greenways and other vegetation within urban areas, such as roads and other infrastructure. Urban green space (UGS) can be an individual element such as a street tree, or larger areas such as urban forests, playing fields and gardens, as well as sidewalk planters (e.g. Davies et al., 2008; Wu, 2008).

UGS can be natural, semi-natural, semi-urban and even artificial (Tzoulas et al., 2007). Jim and Chen’s definition (2006) denotes its location, spatially, as being within the limits of urban settlements and is imilar to those of Kabisch and Haase (2012), Schipperjin et al. (2010); the URGE Team (2004), and DTLR (2002).

Peri-Urban Green Space

As presented above, GS are most clearly defined and understood through their characteristics, especially when compared to other types of green space (i.e. urban or natural) or open space. Peri-urban green spaces (PUGS) are a unique subset found within the concept and definition of GS. Perhaps the overriding descriptor of GS within the context of PURs is that is neither wholly urban nor wholly natural. Clark (2006) would agree: UGS are actually diffused green spaces. PUGS are somewhere in the middle; in the transformative process of becoming

urban, and thus becoming more diffused, but still predominately neither one nor the other: they are not yet post-urbanised.

Characteristically, PUGS most often have a semi-natural or semi-urban vegetation structure to them where the pressures of urbanisation over time have impacted and transformed the vegetative quality and quantity. For example, in PURs, as human development expands into the rural landscape, the local landscape, including the natural and native species of both flora and fauna, are reduced, displaced, replaced, and homogenised with more urban or semi-urban species (e.g. McDonnell et al. 1997; Lockwood and Kinney, 2001; Pickett et al. 2001; Miller and Hobbs, 2002; Antrop 2004).

3.4.1 Interstitial Green Space

Interstitial green spaces (IntGS), in the context of this research, are a unique type of polycentric PUGS. Two varying quantitative and qualitative perspectives provide insights into understanding this concept: spatial and temporal.

Spatially, IntGS occupy a specific region within the landscape. IntGS have many transitional edges (i.e. rather than a physical edge). Whereas a PUGS has one distinct transitional edge where the urban intersects with the rural landscape, an IntGS has multiple edges – they are currently facing urbanisation pressures including fragmentation and spatial heterogeneity and may have already been recently effected by these pressures and subsequent impacts. In this regards, IntGS are difficult to correlate to the urban-rural transect.

Interstitial spaces have gathered much attention, mostly within studies of the urban landscape, and describes interstitial spaces as those leftover, remnant, forgotten, unmanaged or underutilised spaces within the urban context (e.g., Ward Thompson 2002; Matos, 2009; Brighenti, 2013), sometimes called ‘void spaces’. Vidal (2002) referred to these as ‘interfragmentary spaces’. These peri-urban interstitial spaces lack a defined land use and clear ownership, and are often referred to as urban open space. In rural landscapes surrounding expanding cities, the IntGS often consist of the ‘left-overs’ of urban sprawl (Mörtberg and Balfors, 2007); post-suburban development, leftovers of prior GS, and leftovers of prior indigenous or biophysical landscapes.

Many of the fragmented GS within the PUL experiencing urbanisation pressures are IntGS (Matus, 2014); they are remnants of prior, larger GS; sited in between other varied land uses. Many of the definitions for IntGS provided in the literature consider the GS's land use, specifically formal use vs. informal use (e.g. Freeman and Buck, 2000; Bell and Ward Thompson, 2003; Rupprecht and Byrne, 2014) and/or management (e.g. Del Tredici, 2010; Grazuleviciute-Vileniske et al, 2015). As such, the literature has referred to IntGS as informal greenspace (Rupprecht and Byrne, 2014). Examples of informal GS include street verges such as roundabouts and footpaths, brownfields, railway, fences and roofs, rivers and canals, and powerlines among others. These examples focus not only on land use but the level of management as well. The characteristics correlated to IntGS are therefore diverse and consequently are often over-simplified (i.e. informal vs. formal) with most of the focus on urban contexts, as this provides for simple, binary description and visualisation. In reality, however, IntGS are rather more complex.

Temporally, IntGS are more difficult to define. Drawing from the discipline of urban sociology, the term 'interstice' can refer to *"a space without precise use, located for an indeterminate period of time between functionally determined built configurations"* (Levesque, 2002). IntGS are in this sense liminal; they are often temporary and transitory. As focused upon within the discipline of urban geography, liminal spaces possess a state of '*betweeness, intermediacy, or ambiguity of being – the indeterminancy of loose space'* (Franck and Stevens, 2007). Currently (2016) only a handful of literature discusses IntGS in an academic manner beyond mere description to include interrelational aspects (Cristian, 2015; Morgan et al., 2010). Rupprecht and Byrne (2014) define informal green space as an explicitly socio-ecological construct, rather than only cultural or biological. Eduard Bru (2001) refers to informal GS as 'urban voids', noting the prospect of urbanisation that will likely occur upon these GS.

IntGS are commonly defined in terms of what they are 'in-between', rather than what they 'are' (e.g. Matos, 2009; Rupprecht and Byrne, 2014) and have distinct spatio-temporal characteristics that help to define them, therefore,

particularly when compared to other GS (e.g. peri-urban, urban, informal, etc.) as shown in Table 3.1. and Table 3.2.

- IntGS can be located in the peri-urban areas (See Section 3.2.2) of morphologically polycentric and monocentric urban regions (Section 3.2.4) but are more spatially distinct within polycentric peri-urban regions (Section 3.3.4).
- IntGS are most often located on the edge of, or as the transitional space between two larger spaces, often not another green space, but not exclusively.
- IntGS have been and/or are currently undergoing physical transformation due to the impacts of landscape fragmentation (Section 3.3.2) due to the human development and urbanisation process. IntGS are transitory spaces, currently considered green spaces, which have not achieved post-urbanisation and urban land uses.
- Functionally, IntGS exhibit similar biophysical aspects as fragmented green spaces such as reduced ecological integrity, reduced resilience and reduced biodiversity (Section 3.3.3)
- Compositionally, both individually and as a group, IntGS are interspersed (Section 3.3.4), smaller in size, less connected, more isolated from each other, contain more edges, and possess more diversity in characteristics such as shape, edge conditions, vegetation, land cover, and land use when compared to the other green spaces discussed herein.

Table 3.1 Spatial Attributes of Interstitial Green Spaces

The most distinctive characteristic of IntGS is their spatial relationship to other elements within the landscape. The classic example of IntGS are the smaller, disconnected farmlands, agricultural lands, and open spaces found within PURs and PolyPURs surrounded by urban, industrial, commercial and mostly residential land uses (See Figures 3.19, 3.20, and 3.21).

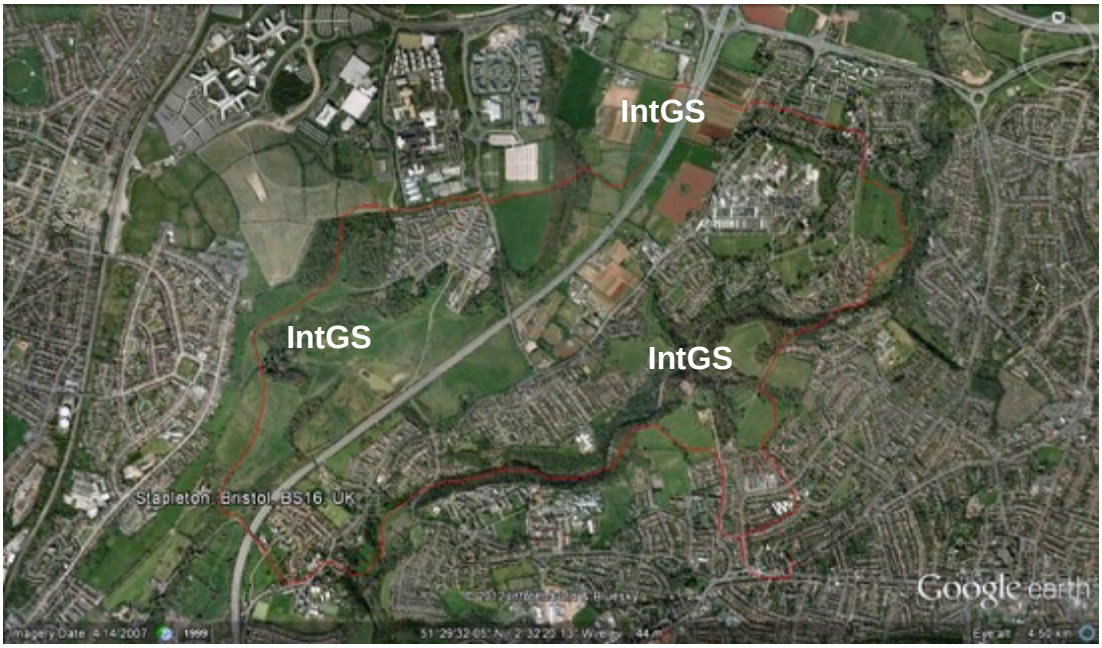


Figure 3.19: Interstitial peri-urban green spaces and green structures within the peri-urban region of Bristol, UK
(Source: GoogleEarth)

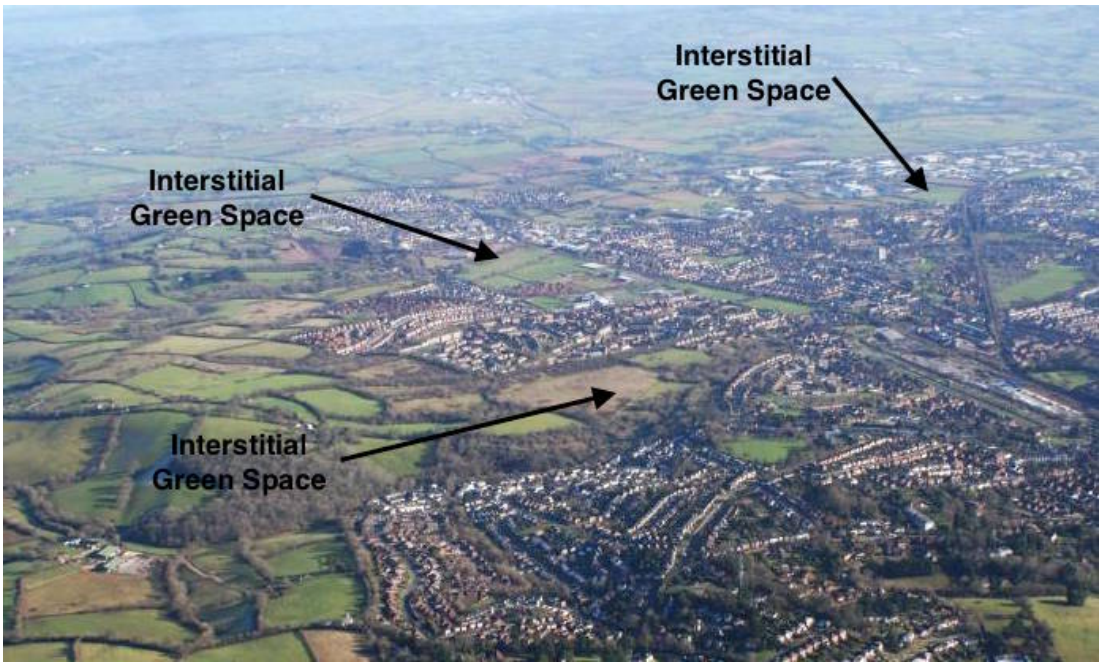


Figure 3.20: Interstitial peri-urban green spaces and green structures within the peri-urban region of South England
(Source: Barn Owl Trust)



Figure 3.21: Interstitial peri-urban green spaces and green structures within the peri-urban region of Kaunas, Lithuania (Source: Grazuleviciute-Vileniske et al., 2015)

- IntGS land cover and land uses are directly affected by the process of urbanisation (See Section 3.2) within peri-urban areas (See Section 3.2.2).
- IntGS are a distinct component of the socio-ecological landscape (See Section 2.5), exist within the context of urbanising landscapes (See Section 3.2.3) and often lack clear land use designation, ownership or function. IntGS are neither fully rural nor fully urban in character (i.e. hybridised) – they are fragments of urban and rural systems, biophysical and anthropological at the same time.

Table 3.2: Temporal Attributes of Interstitial Green Spaces

Summary of Interstitial Green Space

IntGS are fragments of what were previously larger GS, now affected by urbanisation, which has altered their morphology; particularly low density, residential development often as an outcome of urban sprawl - all significant factors in peri-urban landscape fragmentation.

IntGS are in-between. One the one hand, they are in-between non-similar land uses, and, often as transitory GS, the pressures of urbanisation and change are omnipresent. IntGS are also in-between land uses. As components within the PUL, IntGS are also in-between characterisation and description as they currently exist

within the interplay between socio-cultural (anthropocentric) aspects and biophysical aspects of landscape phenomena.

In the context of PURs and PolyPURs, IntGS are not reactive to the pressures of urbanisation, they are interactive: decentralisation and sprawl would not exist as a component of the urbanisation process without the presence of IntGS. This places IntGS at an important fulcrum within the process of urbanisation and subsequent landscape fragmentation that requires further analysis and understanding.

As presented, IntGS are best described and understood through their characteristics, particularly comparatively, and reflective of landscape fragmentation impacts. IntGS are quite similar to PUGS; they share the same characteristics as discussed. The single, overriding factor which delineates polycentric peri-urban interstitial green spaces (PPUIGS) from peri-urban interstitial green spaces (PUGS), however, is that urbanisation pressures upon these IntGS come from multiple directions, not just outward expansion from urban centres into the rural hinterland (See Figure 3.22 and 3.23). As such, the spatial pattern of PPUIGS is within, around, and between developed parcels.

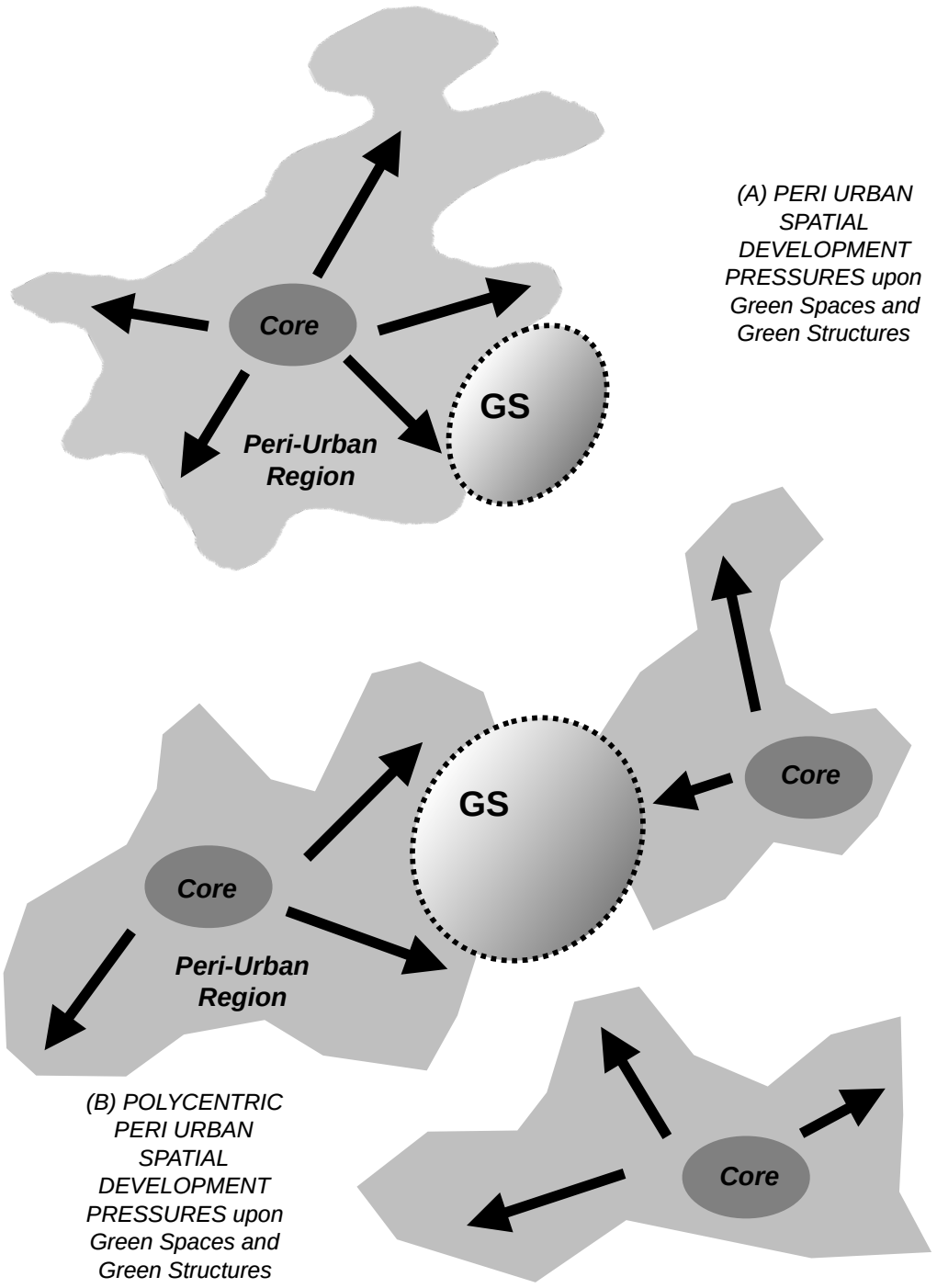


Figure 3.22: Diagram illustrating urbanisation pressures on interstitial green spaces found within (B) polycentric peri-urban regions vs. those within (A) typical peri-urban regions

Grey areas indicate urban population density, lighter areas are less densely populated areas. No density metrics are known, this is a diagram only to show the morphological spatial relationship between the urban areas only.

3.4.2 Operational Definition of Green Space and Interstitial Green Space

Land classification concepts of GS, though descriptive, are often based on the functional use of the land and may not be comprehensive. Although the multiple functions of GS are acknowledged and studied, they are not well integrated into the planning, design and management process (Yli-Pelkonen and Niemelä, 2005; Sandstrom et al., 2006). Furthermore, consistent approaches to the valuation of GS that support decision-making are lacking (Tyrväinen, 2000; Neilan, 2008). Lastly, varied disciplinary perspectives (e.g. geology, sociology, forest ecology) have different definitions for GS, creating difficulties for interdisciplinary research and knowledge bridging.

As presented, there is no one characteristic that distinguishes one green space from another. Definitions vary in spatio-temporal context, disciplinary context, and socio-political climates. As noted, however, there are distinct yet subtle differences between open spaces, green spaces, urban green spaces, peri-urban green spaces, interstitial green spaces, and polycentric peri-urban interstitial green spaces. These differences refer to both the physical structure and spatial relationships.

This research considers green space, inclusive of varied contexts, as a biophysical element within the socio-ecological, hybrid landscape. Building upon the previous definition suggested by URGE, green space is defined, simply, as public and private open spaces, primarily covered in vegetation, which are directly or indirectly available for a diversity of human use and interaction.

Peri-urban interstitial green spaces are defined as the smaller, diverse, isolated, and fragmented green spaces located within the peri-urban areas of urbanising regions. Peri-urban interstitial green spaces are most distinct within polycentric peri-urban regions, as the pressures for urbanisation are more emphatic.

3.4.3 Green Structure

In the literature, green structure can be one word, greenstructure, or two, green structure. This research will utilise the two-word format - green structure. Although the term green structure can also refer to a spatial planning methodology

and management approach - *"to structure in a green way"* (Attwell et al., 2005) this research will focus on the physical characteristics that constitute a green structure.

Green structure provides a framework for viewing and conceptualising green spaces (GS) and IntGS within the landscape as a continuous matrix. Green structure, like green space, is a spatial entity (Sandström, 2002). The concept of green structure builds upon that of GS to include physical interconnectivity. Green structures are more than a sum of their GS, however; they are the spatial network of the landscape.

The term green structure was first used in Sweden in the early 1990's (SOU, 1994) when discussing ecological assets and urban development. The COST C11 Memorandum of Understanding describes the concept of greenstructure as follows: *"As a field of research, 'greenstructure and urban planning' is concerned with the spatial structure of green areas in the urban landscape and with all planning activities that are essential to create conditions for green areas to perform their vital role for the quality of urban life."* This definition and concept of the green structure planning framework evolves from landscape ecology theories (Forman and Godron, 1986) including interconnectivity and management.

Contemporary planning places these aspects of green structure within the concept of green infrastructure, though green infrastructure is commonly considered a planning concept and strategy for green space connectivity (e.g. Ahern, 2007; Sandstrom, 2002), and not a spatial entity in itself (Schueler, 1987); although this has evolved recently to consider physical elements found within the environment (EEA, 2011). This research will therefore not refer to green infrastructure but rather green structure due to the fact that this provides a more direct and more comprehensive understanding of interconnected green spaces.

This section illustrates the progression of thought and analysis in regards to understanding the concepts of the landscape and its green spaces as components of a green structure and as a spatial entity. The key concept of a green structure is that is not only the individual elements (e.g. vegetation, water, etc.) found within a green space but how these GS elements fit into a whole - the distribution and

interconnectivity and organisation of green elements form a system and pattern of green space or a green structure.

Green structures, much like PPUIGS, serve to link spaces. Green structures of all shapes and sizes flow between, and over, buildings as well as the landscape - from the urban centre to the peri-urban perimeter to the rural hinterland. Green structure, therefore, is a basic and dominant spatial entity, or infrastructure, found within the landscape.

This research's definition of green structure will focus on its spatial attributes, specifically interconnectivity. A green structure in the context of this research has two similar descriptive meanings, depending on the scale of reference and the analytical application.

Firstly, green structure refers to a system of green elements or individual green spaces, often physically interconnected. When considering what makes a green structure distinct from a green space, characteristics of connectivity, proximity and integration are prominent. This concept of green structure is best suited to larger scale analysis such as at the city and regional level. In this regard, a green structure is a GS network. The benefit of this 'network' concept is that green spaces and green structures can be addressed in a wider more strategic concept of analysis, recognizing the spatial component of GS as part of a larger system of connected spaces and green structure.

Secondly, green structure refers to the specific, quantitative, physical characteristics of a green space. This conceptual definition highlights the spatial attributes of a green space, not, specifically, its connectivity characteristics as in the previous definition. For instance, the green structure of a GS such as a woodland includes a description of its physical characteristics – its size and shape, its height, width, species composition, number of edges, its density, etc. In this regard, an individual green area (GS) such as a park or green corridor is a green structure containing various green elements that individually describe its physical structure and spatial qualities. Significantly, these individual green space elements (e.g. trees, groundcovers, wetlands, etc.) are interconnected to create the green space, so the aspect of connectivity is not disregarded, just not prioritised.

The terms green structure and interstitial green structure are considered synonymous with GS and IntGS within this research's context, but both will be referred to where needed. Green structure, as such, embodies the current view of the peri-urban landscape as an interconnected system of varied anthropic and biophysical green spaces – a socio-ecological landscape. Beyond their compositional aspects, such as public or private ownership, green structures and their associated GS and IntGS are understood to be an important aspect of the polycentric, peri-urban landscape.

3.5 Types of Peri-Urban Green Space and Green Structure

Within a hybridised PUL, there are a multitude of green spaces and green structures (simultaneously referred to as GS moving forward). This research requires a clear operational classification of GS in order to conduct data collection, mapping and analysis. This section will, therefore, review the literature on GS classification including characterisation, inventories and typologies. Within urbanising landscapes, structural elements are constantly being removed, added or modified. The goal of this section's typological classification of GS is comprehensively to capture not only the hybrid GS typologies found within the polycentric, peri-urban socio-ecological landscape but also new and emerging GS typologies.

The literature provides many strategies for classifying GS beyond composition and configuration (e.g. typical for landscape-level ecological analysis) and includes multi-scalar approaches. Many strategies focus on land ownership (e.g. government, commercial, public, private), management levels (intensive vs. less maintained 'wildscapes'), land use (e.g. zoning, use classes, code of urbanism), and even access (e.g. 24 hour, daylight only, public, private, restricted). Other strategies include descriptive qualities (i.e. Landscape Character Assessment - LCA), human use (e.g. playground, running track, forest park), or even the values and benefits derived from human use.

Bell et al. (2007) provide a core typological classification of GS in differentiating between parks and gardens; natural and semi-natural spaces; green corridors; allotments, community gardens and urban farms; outdoor sport

facilities; amenity green spaces; provision for children and young people; cemeteries, disused churchyards and other burial grounds; other public spaces. Swanwick et al. (2003) produced an inventory of 25 urban green space types, falling into ten subgroups and four main groups (i.e. amenity green space, functional green space, semi-natural habitats, and linear green space). Some typologies combine UGS with other open spaces or urban open spaces such as squares, pedestrian areas and cycling areas (DTLR, 2002; Bell et al., 2006; Steiner, 2012).

The Urban Green Spaces Task Force's report *Green Spaces, Better Places* (DTLR, 2002) focussed on benefits received from urban green spaces and included typologies found within the urban-rural fringe:

1. Parks and gardens;
2. Natural and semi-natural spaces;
3. Green corridors;
4. Outdoor sports facilities;
5. Amenity green spaces;
6. Provision for children and young people;
7. Allotments, community gardens and urban farms;
8. Cemeteries, disused churchyards and other burial grounds;
9. Public space.

This classification is comprehensive, with nine primary GS types, each containing numerous sub-classifications. The typology was promoted by CABE, (2004) and the *Planning Policy Guidance 17: Planning for open space, sport and recreation* (PPG 17) in England which was integrated into many council and municipality policy documents. Although PPG 17 was replaced by the NPPF (National Planning Policy Framework) in 2012 (Department for Communities and Local Government - DCLG, 2012), the typology is still prevalent in public policy such as PAN 65 (Scottish Government, 2008).

Beyond the UK, similar classifications exist; although it tends to be the sub-classifications that provide the contextual variation. For instance, the Central Government in China has promoted a national standard for classification of UGS

in similar format to that of PPG 17 (MOHURD, 2002). Similar classifications exist within Berlin (Berlin Land Use Plan, 2009), Portugal (Paulo Farinha-Marque et al., 2012), and elsewhere in Europe (GreenSurge, 2016). Although GS typologies and descriptions vary slightly according to their context, the literature does have established conventions which inform this research in utilising the following fifteen typological classifications in regards to polycentric peri-urban green space and green structure, as shown in Table 3.3.

Probably, no categorisation can cover all the characteristics and peculiarities that exist in PULs due to their varied natural conditions (e.g. geomorphological, climatic, biological), historical backgrounds, and social demand. In addition, no inventory or classification can be final – social initiatives and revised policy (e.g. urban greening), innovation and technological progress, changed environmental awareness, as well as the creativity of city planners, urban dwellers, and others, perpetually lead to new types of GS (e.g. in urban contexts - community gardens, roof allotments, rain gardens, bioswales, constructed wetlands, mobile and vertical gardens, and different forms of guerrilla gardening). Additionally, Hunter and Luck (2015) note that the literature's commonplace 'land use' and 'land type' categorisations, and other descriptive planning terminologies, do not capture the integrated aspects of socio-ecological GS.

For the purpose of clarity, the typologies provided in Table 3.3 do not include sub-categories or other hierarchical classifications, but it is argued that any type of GS found within the PolyPUR would fall into one of the above categories. For example, the remnant green strip along a highway, the residual lawn or grass areas at a commercial or industrial complex, churchyards, agricultural buffers, seasonal streams, and common areas can all be categorised as noted, albeit with explanation.

Though these GS typologies are shared among PUGS, IntGS and PPUIGS, it is the specific spatial characteristics as influenced larger landscape context of urbanisation and transitional land uses which denote them as PPUIGS.

PERI-URBAN GREEN SPACE TYPOLOGY	TYPOLOGY EXAMPLES
PARK	Public or Private Parks and/or Public Common Areas ***not associated*** with Housing *(e.g village green, dog areas, playgrounds, sitting areas)* Often with traditional green space elements such as benches, fountains, picnic spaces, toilets and other facilities. At various sizes including Reserves. Regional Parks, Metropolitan Parks, District Parks, Local Parks, Small Parks, Pocket Parks.
GARDENS AND GROUNDS	Domestic Gardens. Formal Gardens. Memorial Gardens. Back Gardens. Pleasure Gardens. Public or Private. **Not** an Amenity Green Space (see below). Institutional Grounds, School Grounds, Commercial grounds.
WOODLAND	Deciduous / Evergreen / Mixed / Wet Woodland
GRASSLAND	Meadow / Grassland / Heathland / Scrubland
OTHER NATURAL AND SEMI-NATURAL GREEN SPACE	Conservation sites, heritage sites. Can be wild or designed.
OUTDOOR SPORTS FACILITIES	Play fields and Outdoor Sport Areas such as football pitches, bowling greens, tracks, golf courses, tennis, cricket fields, fishing, etc. Informal recreation areas or an Athletic Complex or Facility
CHILDREN'S PLAY AREA	Playground - Adventure or Equipped.
AMENITY GREEN SPACE	Housing Green Space and Common Areas such as Village Green. Commercial amenity greens space.
GREEN CORRIDOR or RIPARIAN CORRIDOR	Greenway, Parkway, River Walk, Canal Banks, Towpaths, Bridleways. Transport Corridors such as road, rail, cycleways, walking routes.
AGRICULTURAL	Crop land, Fallow Land, Pasture Land. Orchards or Planted Fields. Farmland. Arable and Grazing Land.
ALLOTMENTS, COMMUNITY GARDENS AND CITY FARMS	Nurseries. Garden Commons.
CEMETERIES AND CHURCHYARDS	Burial Grounds, Disused Cemeteries, Crematoriums.
CIVIC SPACES	Civic squares or markets. often with paved surfaces and green areas and trees. Plazas. Transport hub spaces. Not an Amenity Green Space.
RESERVOIR or WATER & WETLAND INCLUDING COASTAL LANDS	Canals, Reservoirs, Dams (Running Water / Standing Water)
OTHER GREEN SPACE	Other natural, semi-natural and semi-urban spaces. Landfills. Vacant Land, quarries, brown fields. Functional green space such as caravan parks. Incidental Green Space or Open Space.

Table 3.3: Polycentric Peri-urban green space and green structure typologies

Chapter 4 - Exploring the Relationship between Human Wellbeing and Green Space within Peri-Urban Landscapes

4.1 Introduction

The purpose of this Chapter is to clarify the remaining important component of the human-landscape relationship – human wellbeing (HWB) – and review how this relationship is operationalised in the literature. The first section provides a review of the concepts and definitions within HWB, including quality of life and life satisfaction. The next section of this Chapter focuses on the role and influences of GS upon HWB and contributes an integrated approach for analysing this relationship within the PUL. This is followed by a detailed analysis and critique of the specific literature and research within GS and the relationship to HWB through the physical, social and psychologial benefits afforded through interaction including synergistic effects. Lastly, this Chapter concludes with a concise set of PPUIGS characteristics of both ecological connectivity and HWB simultaneously within a fragmented context and the transaction-based framework of Affordance Theory to analyse and measure those characteristics and HWB outcomes.

4.2 Quality of Life, Human Wellbeing and Life Satisfaction

This section presents a comprehensive review of the concepts and frameworks utilised to define and measure aspects of quality of life (QOL), human wellbeing (HWB), and life satisfaction (LS) as the theoretical basis for analysing the human-nature relationship within the context of this research through the DPSIR framework. This section will answer the following questions:

- How are the terms quality of life, human wellbeing, and life satisfaction similar in the context of spatial planning and peri-urban landscapes?
- How are human wellbeing and life satisfaction defined?
- Are there ways to measure human wellbeing and life satisfaction?

QOL, HWB and LS are relatively new concepts that developed from the Social Indicator Movement of the 1970's which placed non-economic indicators

within human health and welfare policy (Andrews and Withey, 1976). There are many academic discussions of QOL, HWB and LS, however most are found within the public health and medical fields. Additionally, concepts of QOL and HWB have reached into trans-disciplinary studies such as economics and politics, providing contextual definitions with contingent factors. Although the QOL / HWB / LS dialogue is acceptably interdisciplinary, this has brought about difficulty in agreeing upon measurements, terminologies, concepts and definitions. As noted by Andrews and Withey (1976), LS is evaluated on the basis of satisfactions with various aspects of life within various HWB domains. LS includes concepts of wellbeing, and wellbeing is an integral component of QOL.

4.2.1 Quality of Life

QOL is a term broadly used both by the general public, academics, and amongst policy-makers.[8] Concepts with both subjective and objective measurements are used. Its importance is agreed, but a definitive definition may be impossible to designate since the term means many things to many people (Barcaccia et al., 2013). Overall, QOL is a complex, abstract concept, often used as an umbrella term within literature. Although QOL is inconsistently defined, it is commonly referred to in both research and practice and merits clarification specific to GS and HWB.

Generally, the term QOL is used to evaluate the holistic well-being of individuals and societies, focused on separate dimensions inclusive of overall well-being, such as income, wealth and employment, the built environment, physical and mental health, education, social organisation, social belonging, and recreation and leisure (e.g. Meeburg, 1993; Gregory, 2009; WHOQOL, 1993).

[8] For theoretical constructs on QOL refer to Patrick and Erickson, 1993, Maslow, 1954; (Armstrong, David and Caldwell, Deborah (2004) 'Origins of the Concept of Quality of Life in Health Care: a Rhetorical Solution to a Political Problem', Social Theory and Health , Vol. 2, No. 4, pp. 361- 371; Sandøe, Peter (1999) 'Quality of Life - Three Competing Views', Ethical Theory and Moral Practice , Vol. 2, No. 1; Day, Hy and Jankey, Sharon G (1996) 'Lessons From the Literature. Towards a Holistic Model of Quality of Life' in Renwick, Rebecca, Brown, Ivan, and Nagler, Mark (eds) Quality of Life in Health Promotion and Rehabilitation. Conceptual Approaches, Issues and Applications, Thousand Oaks: Sage, pp. 39-50; Parmenter, Trevor and Donelly, Michelle (1997) 'An Analysis of the Dimensions of Quality of Life' in Brown, Roy (ed) Quality of Life for People with Disabilities. Models, Research and Practice, 2nd edn, Cheltenham: Stanley Thornes (Publishers) Ltd, pp. 91-115; Rapley (2003).

Many models have been developed that capture objective and subjective dimensions of QOL through an individual's life situation. Examples of these domains, or core components, include physical functioning, spirituality, occupational/role functioning, future orientation, social functioning, sexual intimacy, self-determination, environmental functioning and financial functioning (e.g. The WHOQOL Group, 1995; Schalock and Verdugo, 2002; Burger, 2003; The Economist Intelligence Unit, 2005).

The literature expands these domains with specific subcategories or components as well as specific descriptors or attributes of each component. Many components can apply to multiple domains but are not double-listed. These components were selected from multiple sources and theoretical frameworks and although, as discussed previously, it is impossible to list all the components and descriptors related to the concept of 'Quality of Life', the following are prominent within the literature (see Table 4.1):

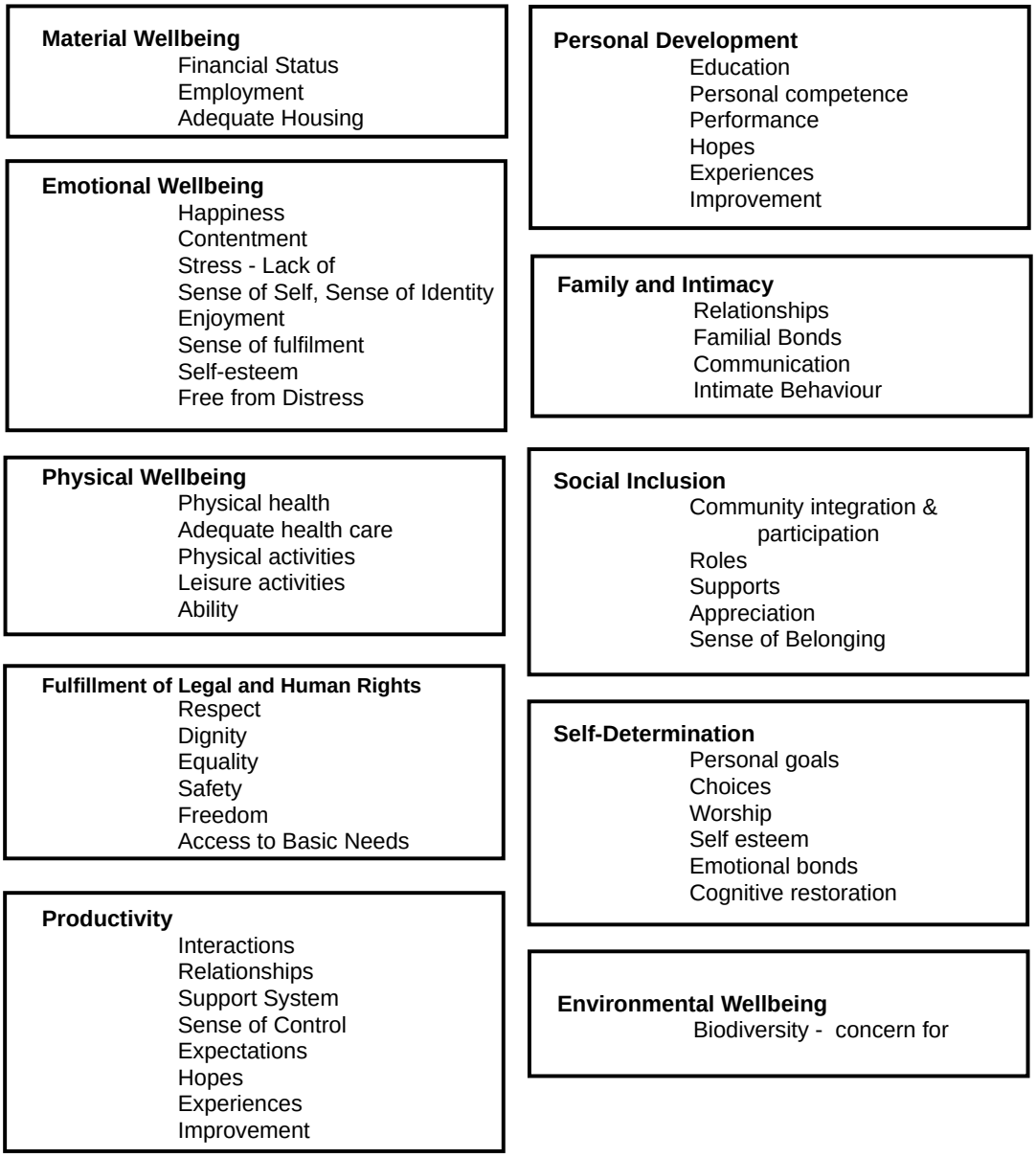


Table 4.1: Quality of Life Domains and Domain Components

In the context of this research, the following four distinct QOL domains and their corresponding components were synthesised and adapted from literature (See Table 4.2):

Quality of Life Domains	*Domain Components* *(descriptors or examples)*
1. Health & Wellbeing	Emotional wellbeing *(happiness, contentment, self-concept, lack of stress)* Physical wellbeing *(health and health care, activities of daily living, leisure)* Environmental wellbeing *(biodiversity)* Rights – legal, human *(respect, dignity, equality)*
2. Social & Community	Productivity *(interactions, relationships, supports)* Family, Intimacy *(communication, intimate behaviour, bonds)* Personal Development *(education, personal competence, performance)* Social inclusion *(community integration & participation, roles, supports)*
3. Psychological & Spiritual	Self-determination *(autonomy/personal control, personal goals, choices)*
4. Economic Wellbeing	Economic wellbeing *(financial status, employment, housing)*

Table 4.2: Quality of Life Domains, Domain Components and Component Indicators

NOTES:
1. Cross-Cultural QOL Components to best degree possible (Keith, 1996).
2. Both Subjective and Objective QOL Components.
3. Multiple item-based indicators (i.e. package-based) were not considered.

This research focuses on the human-nature relationship when providing operational definitions and in the development of constructs. Building on the

definition provided by the Quality of Life Research Unit at the University of Toronto (2015), therefore, quality of life will be defined as the degree to which a person enjoys the important possibilities of his/her life. This construct can be applied to all the domains and associated components listed above. The term 'possibilities' refers to the opportunities and limitations each person has in his/her life, and reflects the interaction of personal and environmental factors – i.e. the human/nature relationship. Although the terms 'important' and 'enjoys' are still subjective, it is the responsibility of the researcher to deconstruct these concepts and descriptors accordingly.

4.2.2 Human Wellbeing as an Aspect of Quality of Life

Human Wellbeing (HWB) is another term often used interchangeably with QOL and, as noted previously, wellbeing is integral to QOL's description and comprehension. The concept of wellbeing has evolved in recent decades as interdisciplinary research has demonstrated its multidimensionality. Currently, however, no agreed upon mechanisms exist that are able fully to capture the diverse aspects of HWB within the socio-ecological or human/nature relationship, or to assess and measure it (King et al., 2014). This section discusses definitions, dimensions and methodological approaches to measuring HWB and LS and the challenges inherent in utilising such measures. This section concludes with a proposed methodological approach for capturing dimensions of objective and subjective wellbeing and LS within a PUL context.

4.2.3 Human Wellbeing Definition

HWB remains an ambiguous concept, without a universally agreed definition and often faced with dissimilar interpretations (e.g. Dolan et al., 2006; McGillivray and Clarke, 2006). In this regard, HWB must be regarded as a multidimensional concept (e.g. McGillivray and Clarke, 2006) (vs. unidimensional or uniscalar).

As supported by the World Health Organization, HWB is:

> *"To reach a state of complete physical, mental and social well being, an individual or group must be able to realise aspirations, to satisfy needs, and to change or cope with the environment. Health is, therefore, seen as a resource for*

> *everyday life, not the objective of living. Health is a positive concept emphasizing social and personal resources as well as physical capacities"* (WHO, 1986, 2012).

Many definitions in the literature refer to a person's 'happiness', 'quality of life' and 'life satisfaction' (Pollard and Lee, 2003) where wellbeing is being *"healthy in a way that includes physical, mental, spiritual and emotional health."* (Dolan et al., 2006). The literature does mention basic needs such as food and shelter, but the majority of definitions focus on the individual's level of happiness.

4.2.4 Dimensions of Human Wellbeing

Components of HWB have perhaps most famously been articulated by's hierarchy of needs (1968), which includes physiological or survival needs as well as other aspects such as needs for esteem, belonging, and safety. Though literature disavows the hierarchical structure of Maslow's model, the components are still considered relevant.

Similar to natural science's ecosystem health assessments of the biophysical landscape (e.g. Rapport et al., 1998), which include deconstructed ecological components, the social sciences have developed wellbeing components for humans. In reviewing over 22 studies, Hagerty et al. (2001) found the following seven broad HWB components included in most research frameworks: relationships with family and friends; emotional well-being; material-well-being; health; work and productive activity; feeling part of one's community; and personal safety (see also Cummins, 1996).

4.2.5 Measuring Human Wellbeing

The literature classifies measures of HWB into two categorisations: objective and subjective measures. Objective wellbeing is measured through factors such as economic, social and environmental statistics, typically with cardinal metrics. Subjective wellbeing, alternatively, is measured through the individual's feelings or experiences, with ordinal metrics (McGillivray and Clarke, 2006) and is considered to be more direct measures of an individual's wellbeing.

Traditionally, wellbeing has been identified with a single objective dimension: material progress measured by income or Gross Domestic Product

(GDP), however this approach has been strongly repudiated as it does not represent comprehensive aspects of human life. Two strategies have emerged to measure multidimensional HWB: one supplemented objective wellbeing measure(s) with additional indicators[9], the other, which this research operationalises, was through solely subjective measures.

Like QOL, HWB is primarily a subjective measure within the social sciences (Diener, 2009), and is thus influenced not only by life conditions and prior experiences, but also by personal values (Keith, 2001). Hone et al. (2014) refers to HWB as 'flourishing', as first noted by Keyes (2002); 'positive functioning' (Huppert and So, 2013; Andrews and Whitey, 1976) has also been documented. Other terms in the literature note 'hedonic' wellbeing, which focuses on the 'feeling' component of wellbeing (e.g., happiness), which is in contrast to 'eudaimonic' wellbeing, which focuses on the 'thinking' component of wellbeing (e.g. fulfilment) (Ryff, 1995)[10].

The subjective wellbeing measures are often simple and direct – assessing individual's thoughts and feelings about one's life and circumstances, and the level of satisfaction with those specific domains (See Section 4.2). This is typically enacted through a self-reported measure of their happiness and life satisfaction.

4.2.6 Human Wellbeing and Life Satisfaction

Life satisfaction (LS) is a term commonplace within the HWB literature. (e.g. Michalos, 1980; Diener and Suh, 1997; Kahn and Juster, 2002) and many define subjective wellbeing in terms of life satisfaction (e.g. Christakopoulou et al., 2001; Christoph and Noll, 2003).

Happiness is often utilised in place of LS (Tatarkiewicz. 1962). From the

[9] The objective wellbeing measures include various social and economic dimensions such as education, income, health, family size, car ownership, home ownership, environment, and others (e.g. Marks et al., 2006; Vemuri and Costanza, 2006; HPI, 2016). This index utilised composite measures to capture the multidimensional aspect of human wellbeing. This approach is viewed as economic-centric and 'consumptive' oriented, however (Stiglitz et al, 2009), and there are concerns over the accurate measurement of those dimensions (Conceição and Bandura, 2008). Additionally, indices tend to oversimplify the complex dimensions of human life and the multidimensional aspects of human wellbeing

[10] Eudaimonic theories maintain that not all desires—not all personal-valued outcomes—would provide aspects well-being when achieved (Ryan and Deci, 2001)

philosophical perspective, LS is utilised primarily as a social indicator of QOL in the literature and is often used interchangeably with happiness. Happiness, however, cannot be directly equated with subjective wellbeing. Bruni and Porta (2007) note that LS and happiness are both cognitive dimensions of individuals, but happiness is solely a 'cognitive component' (i.e. belief, knowledge, attitude) whereas LS is additionally an 'affective component' (i.e. feelings, emotions), thus providing more direct measures to analysis.

As defined by Veenhoven, *"Life-satisfaction is the degree to which a person positively evaluates the overall quality of his/her life as-a-whole. In other words, how much the person likes the life he/she leads"* (1996, p. 3). As with any subjective analysis, however, the variables and qualities of life satisfaction must be clarified (e.g. satisfied with what aspect of life… satisfied with which domain…) (Ward Thompson, personal communication, 2015).

This research will define LS as the degree to which an individual experiences himself/herself as being able to attain his/her goals. This definition supports Musschenga's concept of LS and QOL as well as Campbell et al. (1976) to include components of personal aspiration, achievement, and satisfaction. In this regard, LS serves as an indicator of HWB that individuals have adapted to their situation in life. For this research's experimental design, LS is a distinct construct of the four human wellbeing domains: physical, psychological, social and economic. Keyes (2002) supports this, stating that LS requires the combined presence of high levels of emotional, psychological and social wellbeing aspects through the lens of functioning, both individually and in society.

4.2.7 Summary - Quality of Life, Human Wellbeing and Life Satisfaction

Research often equates wellbeing with one construct such as QOL or LS. Not only does this discount the diversity of characteristics of wellbeing, it also omits other important aspects. As a result, Gasper (2004) argued that new measures need to respect the diversity of wellbeing. Meeberg (1993) importantly remarked that QOL has both subjective and objective aspects and more than one dimension, while LS is purely subjective and refers to a person's feelings of happiness in his or her life.

Both QOL and HWB are multifaceted constructs (e.g., Diener, 2009; Stiglitz et al., 2009) with interacting and changing subjective and objective measures. HWB represents how well human needs are met and the extent to which individuals or groups perceive satisfaction or dissatisfaction in the various QOL domains. Yet there is no agreement as to which components should be included in a valid theory and measure of wellbeing (see Ryan and Deci, 2001; Hird, 2003; Diener, Scollon and Lucas, 2003). Regardless, whenever any of these terms and constructs are used, explicit qualification is required. For example, objective wellbeing does not fulfil the cognitive concept of 'needs' as clearly as subjective wellbeing (King et al Novo, 2014). Furthermore, clarification within the specific domains of wellbeing and/or life as a whole is required within LS questions (Camfield and Guillen-Royo, 2010).

4.3 The Role of Green Space and Human Wellbeing

The role of GS and HWB within the human-nature relationship is the focus of this research and critical to understand in the face of continued urbanisation and landscape fragmentation, particularly to PPUIGS. The next sections answer important questions:

- What are the conceptual frameworks for analysing the human-green space relationship specific to HWB?
- How is the green space – human wellbeing relationship evaluated?;
- What is the influence, positive and negative, of green space on human wellbeing?

4.3.1 Integrated Frameworks for Analysing the Human-Nature Relationship within the Peri-Urban Landscape

Europe's polycentric urbanising regions contain hybrid landscapes and GS that are neither urban nor natural, and as a relatively new and unique landscape typology, these components of PULs require further study. This section reviews the approaches and analytical frameworks used in the literature to study this complex human-nature relationship within the particular context of landscape fragmentation impacts to PULs, PPUIGS and HWB.

Humans and human communities influence—and are influenced by—the landscapes or ecosystems of which they are a part. Ecosystems can develop naturally or be designed. Designed systems are human creations; anthropocentric physical structures which integrate with natural systems, thus creating hybrid landscapes. As humans integrate more and more with natural systems, the relationship becomes more complex.

As shown in Chapter 3, the concept of the PUL is integrated – a socio-ecological system – and thus an integrated approach to theory, analysis and methodology is required. Though many models and theoretical constructs of the human-nature relationship exist, most of these are predominately ecological frameworks or anthropocentric frameworks and thus render any causal relationship as too variable for correlation and mutuality.

For example, landscape ecology, and its counterpart urban ecology, although highly comprehensive approaches to the contemporary, complex, socio-ecological landscape, lack some important attributes necessary to be the lens through which to examine the human-nature interaction (Ranta, 2012); specifically the phenomena of landscape change. Landscape ecology is still rooted as a natural science discipline and lacks appropriate disciplinary integration to address complex problems within an anthropocentric landscape. Additionally, it has been noted that the discipline of landscape ecology does not provide the appropriate methodology to address the contemporary and evolving set of issues of concern and problems in the real-world (Nassauer and Corry, 2004). It has been noted that the scientific tools for analysis found within landscape ecology are too prescriptive and even too complex and resource intensive for interdisciplinary application (Azerrad and Nilon, 2006). Lastly, any examination into the landscape requires sufficient human-based knowledge, and both the scalar perspective and spatio-temporal analysis approaches found within landscape ecology may exclude place-specific relationships.

Overall, landscape ecology is a valuable integrated ecological science having introduced geographic and spatial dimensions to ecological system studies, therefore bridging human, or social, and natural sciences. Landscape ecology has

contributed to spatial planning and design, particularly within conservation and management policy (Forman et al. 2003). Since landscape ecology is dependent on the scientific interpretation and understanding of landscape, however, it has increasingly been challenged by new socio-ecological perspectives (Wu and Hobbs, 2007).

The socio-cultural or anthropological frameworks (e.g. environmental sociology, human geography) are primarily reactive to environmental concerns and problems, such as landscape fragmentation, and are natural resource management focused (Berkes and Folke, 1998), predominately viewing humans as independent from the larger ecosystem.

Although anthropological theory frameworks include natural resources within the socio-cultural context, these viewpoints exclusively seek to improve the *performance* (i.e. ecosystem services delivery) of the natural resource systems (i.e. maximise ecological function). This approach, although valid, requires the understanding not only of the systems that embody the resources but also the institutions that administer them – i.e. human-based socio-cultural and economic systems. In the traditional social-based planning framework, the focus is on the resource *user* not the resource itself, and the inherent processes are viewed within the social system alone, with the ecosystems kept external (Lutzenhiser, 1994), thus embodying a strictly social or anthropocentric view of the landscape or natural environment rather than a holistic one.

As discussed, ecosystem thinking has broadened to incorporate humans not just as outside disturbances but as integrated with other biological and physical processes as was as structures. Most paradigms perpetuate the interdependence of social systems and ecological systems, however.

This ideological division between the social sciences and the ecological sciences persists in many of the theories and frameworks used in research, as well as contemporary spatial planning, environmental planning and landscape architecture. Historically, these paradigms have viewed each as autonomous systems, independent of one another (Agrawal and Gibson, 1999; Koomen, Dekkers and van Dijk, 2008) whereas the human or social-based systems have

viewed all processes internally without external or ecological impacts (Berkes, Colding, and Folke, 2001) and the nature or ecological-based systems have viewed humans and their actions as external to or segregated from the ecosystems (Liu et al., 2009).

For example, edge effect is a common occurrence in PULs (Hardt et al., 2013), where anthropogenic modifications to the landscape such as road and infrastructure construction, residential housing, and other human development practices exist. A literature search (2016), however, showed many articles exist on fragmentation, there is little specifically on edge effects within PULs and how these affect humans.

Ecosystem Services Framework

The Ecosystem Services (ES) framework focuses on the integral, dynamic, and complex interactions of the biotic and abiotic components of the landscape (Limburg et al., 2002). ES has its origins in biology (natural sciences), and ecological-economics (social sciences), and focuses on sustainability and the continuation of ecosystem functions by translating ecological structures, functions and processes into value-based operations and objects (de Groot et al., 2002). A detailed discussion on ES including definitions is provided in Section 4.4.1. Regardless, ES is an integral component of EU policy and grew out of the desire for a better understanding of the relationship between the environment and HWB through the significant initiatives of the Convention on Biological Diversity (United Nations 1992) and the Millennium Ecosystem Assessment (MA).

4.3.1.1 The DPSIR Model

A modified P-S-R model (OECD, 1994), the DPSIR (Driver-Pressure-State-Impact-Response) model (EEA, 2003) is used in the research. This is specific to societal and environmental relationships and is commonly used as a means to assess measure and, potentially, manage the environment (Feld et al., 2010; Kristensen, 2004; Pinto et al., 2013; Bell, 2012). The DPSIR framework clarifies interrelations and complex connections (i.e. cause-effect) between humans and the environment and can help explain these processes in a logical way. Here, the DPSIR integrated modelling structure is used to decipher, analyse

and synthesise landscape fragmentation and urbanisation within peri-urban, interstitial green spaces and the consequent effects upon human wellbeing.

The DPSIR framework has shown advantages, both conceptually and practically, in simplifying complex human-environmental systems, qualitatively describing their interrelationships and aiding in associated policy making (Burkhard and Müller, 2008; EEA, 2007; Turner et al., 1998; Zhou et al., 2014). It is a transparent and relatively simple concept with five recognisable elements that facilitate communication and knowledge dissemination (Pullin et al. 2004).

The DPSIR framework clarifies the interrelations and complex connections (i.e. cause-effect) between humans and the environment and can help explain these processes in a logical way. In the context of this research, the DPSIR integrated modelling structure helps to decipher, analyse and synthesise landscape fragmentation and urbanisation within PPUIGS and their effects upon HWB.

The DPSIR framework is utilised by the European Environment Agency (EEA) and the United States Environmental Protection Agency (US EPA). The DPSIR Model was used between 2007 and 2011 in land use change studies in Europe's Peri-urban Land Use Relationships (PLUREL). Svarstad et al. (2008) summarised the primary strength of the DPSIR framework as its ability to capture the key relationships between environmental, social and economic factors or indicators. The constituents of this research's DPSIR model are:

- Driving Forces,
- Pressures,
- States,
- Impacts,
- Responses.

As a theoretical modelling structure, DPSIR represents a systems analysis view of the peri-urban landscape. Drivers are the human activities that affect the landscape through pressures or direct stresses. These pressures influence the current state of the landscape, and these states in turn affect the landscape through various resulting impacts; impacts which require a response and decisions or actions to ameliorate undesired impacts (See Figure 4.1).

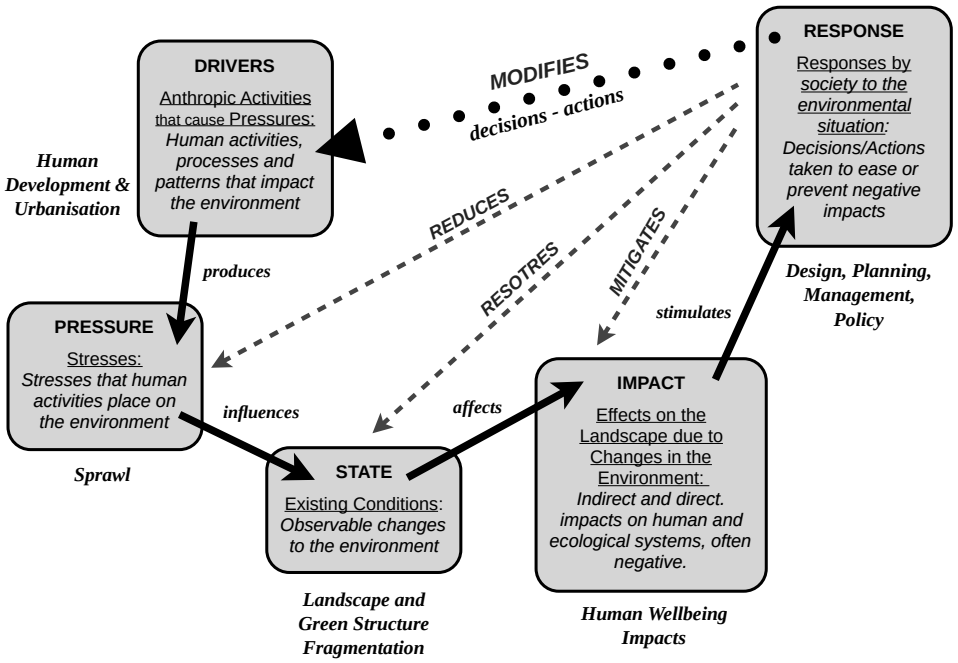


Figure 4.1: Theoretical DPSIR Framework Diagram for Landscape Fragmentation within Peri-Urban Landscapes (adapted from EAA, 2007)

As in the original PSR framework, the arrows connecting each element indicate that, while the framework itself appears linear, the causal relationship between each portion is a synergistic product that occurs across space and time.

In the context of this research's DPSIR model regarding peri-urban landscapes, fragmentation and human wellbeing impacts, the drivers are the activities, often anthropogenic, that produce change in human and biophysical patterns and processes, such as urbanisation. Patterns are states of the spatial and temporal distributions of human or environmental variables such as forests or housing developments. This continuing urbanisation creates pressures for certain conditions within the landscape; here, spatial fragmentation. Processes are the mechanisms by which humans and biophysical elements interact to affect the conditions of the landscape. This state and pattern of landscape fragmentation in turn influences both environmental and human processes, and this information can be used to assess the resultant environmental responses, changes and feedback on those anthropocentric drivers. Overall, each element within the model can be affected by responses, illustrating that this process is not linear but synergistic, and thus supporting the view of a SES and PULs as discussed previously.

Criticisms of the DPSIR framework note the distinct causal relationships between model elements and its inability to account for the interrelationships that exist within complex SES (Niemeijer and Groot, 2008) due to DPSIR's hierarchical structure (Tscherning et al., 2012).

Both of the above frameworks, therefore, have the potential to be used to conceptualise the human-nature relationship within PULs and serve as a link between the natural sciences and social sciences. Within PULs, the human relationship is typically from HWB and 'needs' perspectives; while the ecological relationship is focused on ecosystem functioning and processes. Both frameworks view the interaction between the social (S) and ecological (E) systems as one-way, either first viewing the effects of human actions on the ecological system and its functioning and processes (S to E), or, vice-versa, viewing the impacts of ecological structure and function upon humans (E to S). Overall, however, while systems theory and the SES approach seek to improve this relationship to better understand feedback and other relational components, there is currently a lack of applied research (Binder et al, 2013), mostly due to the difficulties discussed above.

Furthermore, the ES framework is value-based, and often hedonic, in that ecological processes are conceptually translated into value-laden entities or components (Costanza, 1997; Daily et al., 2000). The concept for ES grew from conservation-based dialogue expressed through economic-based goals. As such, the ES 'value' is viewed as similar across the board – for all people of all characteristics, though recent advances in this model are becoming prevalent and more contextual. DPSIR, contrastingly, conceptualises the socio-economic processes through drivers and responses, which is more comprehensive, and allows for a wide range of values and human-oriented benefits to be considered (Dinnie et al., 2013). Spatially, both approaches are effective at any spatio-temporal scale, though ES often works better at larger, regional scales. Measurement of impacts such as fragmentation within the DPSIR approach occurs within the state component whereas in the ES framework, impacts and affects are often overlooked favouring results and output (i.e. wellbeing benefits). In this

regards, the ES framework provides a much less direct measure of those benefits specific to the PUL's components or structures. That is, direct feedback from the ecological system is not considered; within ES's eco-centric perspective, the ecological system is conceptualised in terms of its internal functioning.

As an assessment-oriented framework, ES, as enacted through the Millennium Ecosystem Assessment (2003) or the Vulnerability Assessment Framework of Turner et al. (2003), provides descriptive mechanisms for the relationship between humans and wellbeing, but focus more on problem identification and problem-solving processes than on prescribing the actual actions that are to be undertaken (Cumming, 2014).

Although the ES approach is increasingly significant within literature, there are still challenges to be acknowledged. Beyond the utilitarian approach and potential commodification impacts to ecological resources (e.g. Robertson, 2006; Norgaard, 2010), the ES approach has not illustrated strong applicability to the phenomena found within the human-nature relationship, specifically human actions or responses including management (Vatn and Vedeld, 2012; Primmer and Furman, 2012).

The human-ecological relationship drivers or output goals within each framework are the same – i.e. human needs and benefit – but DPSIR is more comprehensive, allowing for specific components in the relationship to be analysed in more detail. This research's goal is to build a solid understanding of the factors that affect the relationship between fragmented GS and HWB – not the beneficial outcome alone, which is the goal of the ES framework. Although feedback is still limited between social and ecological aspects of the system, the DPSIR approach acknowledges impacts, both ecological and human-based, within the interrelated model, thus allowing for a cyclical relationship as expressed through the model's Responses.

In addition, both frameworks can be considered action oriented, but within the DPSIR framework, the transactional process between the individual and the landscape can be more comprehensively deconstructed to analyse and review the specific components within the PUL such as:

1. those PPUIGS affected,

2. those PPUIGS that provide a HWB benefit.

Given this research's context of polycentric, fragmented, peri-urbanising regions where the pressures of urbanisation and resultant fragmentation impacts are anthropocentrically founded, DPSIR is distinctly a modelling framework and its unique and comprehensive analytical approach is able to capture the dynamic aspects of the human-nature relationship in order to complete this research's goals and objectives.

4.4 The Influences of Green Space upon Human Wellbeing

A breadth of literature across multiple disciplines discusses the influences of GS upon HWB (e.g. Saunders et al., 1991; Taylor, 2000; Jongman, 2002; Bogaert et al., 2005) such as air quality, water infiltration, and carbon offset, among others. However, research encompassing the human-based benefits and impacts such as QOL, wellbeing and human welfare, particularly beyond public health spheres, is limited, however, especially as related to spatial planning and design within policy decisions. (see Appendix 1 – Literature Review Results). An exhaustive review of the varied connections made in the literature between humans and nature or GS would be imprudent. This research aims to identify those specific facets of the human-nature relationship that have been identified as the HWB characteristics specific to GS and, where possible, PPUIGS. The literature provided to support these relational effects focuses on empirical research from multiple disciplines with measurable outcomes and results. Ethnographic and historical studies have been omitted from the literature search, however.

Furthermore, the human-nature relationship pervades seemingly inexhaustible subject areas and disciplines; hence it was impossible to provide a complete review. Overall, this research highlights the substantive facets and notes those poorly represented in scientific literature. Minimal literature explores the specific and unique aspects of peri-urban and/or interstitial GS, thus an analysis of GS will suffice with consideration of the specific physical and spatial

characteristics that apply to PPUIGS. The next sections will review the relevant concepts utilised to evaluate this relationship.

4.4.1 Ecosystem Services and Landscape Services

Reflecting the interconnectedness of social and ecological landscapes (SELs) found within PURs, recent conceptual frameworks of HWB have striven to illustrate the linkages and between HWB and the landscape, with this being achieved predominately through the concept of ecosystem services and natural capital (MEA, 2005; Costanza et al., 2007; Smith et al., 2013).

Although the concept of ecosystem services has permeated many disciplines, four primary definitions are most common in the literature:

- the benefits people receive from ecosystems (MEA, 2005);
- *"the conditions and processes through which natural ecosystems, and the species which make them up, sustain and fulfill human life"* (Daily, 1997);
- "*Ecosystem services are components of nature, directly enjoyed, consumed, or used to yield human well-being"* (Boyd and Banzhoff, 2006);
- *"the benefits human populations derive, directly or indirectly, from ecosystem functions"* (Costanza et al., 1997).

The concept of ecosystem services (ES) is directly tied to the landscape's structure, pattern, and form. Taken as a whole, these four established definitions illustrate human-based benefits; though there are continued discussions to the varied meanings and semantics of the terms used such as 'outcome' and 'function' (Fisher, Turner and Marling, 2009).

The Millennium Ecosystem Assessment's (MEA) classification system is the most accepted and prominent in literature. The MEA report unfurled a wider understanding and use of ecosystem services and offered an expanded, heuristic classification system (2005). However, Boyd and Banzhaf (2007) provided the following updated definition informed by economics and accounting principles: *"…ecosystem services are components of nature directly enjoyed, consumed, or used to yield human well being"*.

The MEA's definition of cultural ecosystem services, however, opened the door to benefits beyond the economic-oriented end-products of ecological systems and phenomena (e.g. clean water, clean air) to include cultural meaning, recreation, psychophysiological and spiritual fulfilment (MEA 2005, p. 40; see also de Groot et al., 2005). These cultural benefits do not fit Boyd and Banzhaf's economic valuation perspective, but are nonetheless important to meet ecosystem service necessities of 'well being' and 'human welfare' and cannot simply be disregarded. Unfortunately, much of the benefit humans receive from cultural ecological services and the landscape do not have an agreed upon quantitative measurement or valuation. It is this concept of 'cultural goods and services' (UNESCO, 2004) that allows a more focused lens into the definition and characteristics of ecosystem services, specifically, a framework for understanding a comprehensive suite of human benefits received from the landscape.

Based on the idea that landscapes should be seen as spatial human-ecological systems delivering functions valued by humans, and that humans change the landscape to improve its functioning, and to obtain added ecological, social and economic benefits, Termoschuizen and Opdam (2009) suggest the concept of landscape services instead of ecosystem services. Complementing this research's definition of landscape as an interdisciplinary research context, the term landscape services is more appropriate as this term more readily includes the anthropic and biophysical concepts and spatial characteristics of PULs and their hybridised ecosystems. This research does not, however, consider landscape as a replacement for ecosystems, or as a group of ecosystems, as supported by Termoschuizen and Opdam, but takes the position that landscapes are a spatio-temporal, integrated human-ecological system that provide a wide range of functions that are valued by humans for various psychological, physical, social, economic and ecological reasons. Additionally, Baker et al. (2012) noted that alternative terms such as 'landscape services' allow for wider comprehension as people may not feel like they live in an 'ecosystem' as it is often taken quite literally, but they are more comfortable with understanding that they live in a 'landscape'.

This research will also use the term benefits when referring to values or, as mentioned above, the 'functions that are valued by humans'. This is primarily in order to differentiate ES from, and expand upon, the more human-based benefits received from the landscape not explicit to the biophysical landscape. Although terms such as 'cultural ecosystem services' and 'natural capital' (Lamarque et al., 2011; MEA, 2005) expand traditional ES definitions to include the benefits found within the socio-ecological landscape, landscape services are specific to this research's context of polycentric, PULs currently undergoing urbanisation and exhibiting the effects of fragmentation. Examples of landscape services not typically accounted for in ES benefits include the concept of social capital, i.e. knowledge sharing and social-wellbeing benefits achieved through social interaction (Vallés-Planells et al., 2014); these are common in urban and peri-urban areas but lacking within more rural areas. Additionally, concepts such as management, socio-cultural/recreational facilities and their accessibility, and even vegetation characteristics, are not able to be included in traditional ES approaches.

In summary, the concepts of LS and HWB are diverse and subjective, and thus an expanded and comprehensive system to account for those benefits received from the PUL is required. PPUIGS provide both socio-cultural and ecological capacities within the landscape services paradigm. Furthermore, landscape services are co-produced by humans and nature and, at the same, benefit both humans and nature.

This discussion of ES and landscape services was necessary, not only because it illustrates the evolving dialogue within social sciences, but to set the stage for the measurement and valuation of landscape services or HWB benefits within this research's framework, particularly in the methodology and data collection phases. Additionally, the concept of landscape services more comprehensively includes the indirect and direct benefits that humans (Costanza, 1997), society and nature receive from the landscape, and thus serves as a link between the biophysical and social sciences (Burkhard et al., 2012).

4.4.2 Ecological Integrity and Landscape Integrity

This research's assessment of the human-nature relationship is best represented through the concept of 'landscape integrity' (Liu and Taylor, 2002). The term 'landscape integrity' has been primarily discussed within ecological disciplines (Hellmund and Smith, 2006), which often to refer to 'ecological integrity' or 'ecological health' and frequently disregard the sociological context of the conjoined anthropological and biophysical systems. Paul Hellmund and Daniel Smith, in their book Designing Greenways, addressed this disjunction:

> "*… Although this term [landscape integrity] has sometimes been used with a meaning more focused on natural systems, the pairing of these two words suits the broader goal of ecological and social quality… To evaluate landscape integrity is to consider the overall quality or health of the landscape, including ecological and social functions."* (2006, 6).

Landscape integrity is not the same as ecological integrity. Ecological integrity, although a valuable metric for environmental quality, is concerned with ecosystem functionality (Forman, 1995; Karr, 1992) and ecological system dynamics (Parrish et al., 2003), and as a conservation tool, values non-human environments, disvalues human environments, and does not regard humans as integral components of the ecosystem (Barkman, 2002; Arntzen and Brady, 2008).

Alternatively, landscape integrity requires that the systems and the landscape elements present be 'healthy', or that there exist sufficient levels of complexity and diversity within its functions and structures to maintain self-organisation over time (Woodley et al., 1993). Scottish National Heritage defines landscape integrity as the "*intactness of the individual characteristics of a landscape*". This viewpoint considers the landscape condition or intactness "*from an ecological, functional and visual perspective"* (2002). These definitions of landscape integrity incorporate humans into ecosystems.

4.4.3 Landscape Integrity and Sustainability

Landscape integrity is a term that encompasses a similar definition to that of sustainability. The United Nations sustainable development report (WCED, 1987) presented concepts for sustainability and sustainable development that have

been adopted and adapted by most disciplines and sectors. Although multiple definitions of sustainability currently exist (Mussachio, 2009), most spatial-planning and ecological-based definitions highlight the desire to maintain resilience in environmental and social systems by meeting a diverse range of interconnected environmental, social and economic and institutional goals (Swart et al., 2004).

Sustainability was originally an ecological term (Becker and Jahn, 1999). The term sustainable development, however, has moved beyond ecology into society and the social sciences, and sustainability in contemporary culture is often defined with economic-centric idioms. Although the three tiers of sustainability – economic, environment and social – are all interrelated, the economic tier is a wholly anthropocentric term (Tisdell, 2000) and thus landscape integrity, i.e. sustainability, is a socio-ecological concept. Furthermore, landscape integrity incorporates social and ecological systems and processes more comprehensively than sustainability or sustainable development (Hellmund and Smith, 2006).

Academia and the professional practice in a wide range of disciplines are apt to utilise the term sustainability in place of landscape integrity, but this is erroneous. Richard Forman (2008) notes similar concerns stating *"I usually avoid the term [sustainability] as mainly being a goal reflecting each user's agenda rather than a base of knowledge, and more to the point, it feels about as solid as sitting on a chair of jello, or toothpaste"* (2008, 252). Notwithstanding this, sustainability is entrenched within literature and cultural discourse. The term's endemic use requires its acknowledgement but this research employs landscape integrity where appropriate and pertinent.

4.5 The Wellbeing Benefits of Human Interaction with Green Space

Contact with the natural environment such as GS is a fundamental component of HWB (Wilson, 1984; Miller, 2005). Matsouka and Kaplan (2008) reviewed 90 studies from the scientific journal *Landscape and Urban Planning*, and like Bowler et al.'s (2012) analysis concluded there was strong evidence that GS within the urban landscape is important for HWB. Furthermore, nearby GS influences wellbeing beyond spatial interaction (Tennessen and Cimprich, 1995;

Kaplan, 2001).

International studies in the Netherlands, Denmark and the United Kingdom have also found that nearby UGS positively influenced various aspects of human wellbeing. Higher levels of perceived general and mental health, lower stress levels, lower likelihood of obesity and fewer health complaints were among the health measures associated with greener environments (Grahn and Stigsdotter, 2003; Vries et al., 2003; Ellaway et al., 2005; Maas et al., 2006, 2009; Mitchell and Popham, 2007; Nielsen and Hansen, 2006; Sugiyama et al., 2008; Stigsdotter et al., 2010; van den Berg et al., 2010; Korpela et al., 2014).

Recreational parks and GS provide opportunities for healthy physical activity and the relief of stress. Furthermore, the passive benefits to physical and mental health of an urban landscape with trees have been documented in industrialised countries (Ulrich, 1984); enjoyment of green areas may help people to relax or may give them fresh energy. Such findings broadly confirm the conclusions of others concerning contact with nature, reduction of stress and escape from dense urbanity (Ulrich, 1979; Greenbie, 1981; Kaplan and Kaplan, 1989; Bussey, 1996).

Furthermore, HWB benefits provided from GS include speedier medical recovery (Ulrich, 1984), increased physical health (Li, 2009) and cognitive functioning (Kuo, 2001), mental restoration (Hartig et al., 1991), establishing a sense of community (Kim and Kaplan, 2004), and longevity (Takano et al., 2002). Recent studies correlate that more GS results in increased mental health and lower levels of stress (Dillen et al., 2012; Ward Thompson et al., 2012) and increased social relationships (Sullivan et al., 2004).

Participation in environmentally responsible behaviour such as community gardening has been associated with greater levels of personal happiness. For example, Brown and Kasser (2005) found a positive relationship between subjective wellbeing and ecologically responsible behaviour. This effect on psychological wellbeing is consistent with other research into the benefits of participating in ecological restoration schemes or community gardening initiatives.

Negative Aspects of Green Spaces on Human Wellbeing

Alternatively, GS are not always regarded as positive and the benefits derived from interaction with them not always beneficial. For instance, GS, particularly in more urbanised areas, are viewed as dangerous (Ward Thompson et al., 2004; Jorgensen et al., 2007). Other GS characteristics, such as a lack of maintenance and cleanliness, or dense vegetation, may reduce social interaction and thus the development of social ties and social cohesion. GS carry disease and allergens (Ribeiro et al., 2009); children can procure serious injury from play within GS. GS can become overcrowded (Arnberger and Haider, 2005) leading to potential user conflicts (Arnberger, 2006) and even violence, as well as the reduction in the quality of the vegetation due to overuse (Kissling et al., 2009).

4.5.1 Human Wellbeing Dimensions Specific to Peri-Urban Landscapes

Supporting the landscape services concept discussed prior, literature has noted five overarching dimensions that contribute to HWB found within the human-nature relationship of PULs:

- Environmental Wellbeing;
- Economic Wellbeing,
- Emotional Wellbeing;
- Physical Wellbeing;
- Social Wellbeing.

Sometimes referred to as environmental wellness within human lifestyle discussions, environmental wellbeing is the capacity of the natural environment to support, sustain and be resilient to the activities of people and communities (e.g. MEA, 2011; EEA, 2013; Haines-Young and Potschin, 2010). This concept is founded in the natural sciences and ecosystem health (i.e. biophysical integrity) but includes notions of environmental attitudes and human impact. This research does not focus on this particular aspect of the human/nature relationship nor measure it, although the concept is applicable within natural science disciplines.

Economic or material wellbeing is an individual's or family's standard of living based primarily on how well they are doing financially and includes material living conditions (OECD, 2013).

Emotional wellbeing relates to people's emotions, thoughts and behaviours and is defined as one's ability to understand the value of emotions and use them to move life forward in positive directions (Mental Health Foundation, 2012). Additionally, many of the subjective concepts found within economic wellbeing (see OECD, 2013) are considered aspects of emotional wellbeing, although not explicitly stated in those terms. Significantly, emotional wellbeing is inclusive of concepts and definitions of psychological wellbeing (Bradburn, 1969; WHO, 2010), but this research chooses the term 'Emotional wellbeing' and includes psychological wellbeing traits, whereas psychological wellbeing does not consistently measure aspects of emotional wellbeing.

Physical wellbeing relates to the functioning of the physical body and is affected by disease and injury, often equating to physical health. Social wellbeing relates to social interactions at community or societal level and relationships with others on a one-to-one, small group or family level.

This research will focus on the physical, psychological and social HWB benefits received from interaction with GS, focussing on a PolyPUR context. The ecological and economic benefits to humans must also be addressed briefly, however.

Ecological Benefits

The ecological or environmental benefits of GS have long been studied and there is a mass of empirical data in the literature. This includes work on air quality and water quality (Tyrväinen et al., 2005), habitat function, carbon sequestration, reducing energy consumption and grey infrastructure costs, as well as resilience to climate change, decreased urban core temperatures and increased biodiversity (e.g. Bolund and Hunhammar, 1999).

Economic Benefits

The economic benefits of GS are another well-researched component within the literature and, particularly, public policy. Adding to the cost-saving component of the environmental benefits as above, health care costs decrease when GS are interacted with. Additionally, property values increase when GS are nearby or visible (Kong et al., 2006) and tourism has been noted to increase with

GS such as National Forests or National Parks (e.g Archer and Cooper, 1994; National Parks UK, 2013). High quality GS also attract businesses and higher wage employees (e.g. Forestry Commission, 2012; Lee et al., 2015).

Physical Benefits

Copious literature has shown the positive and direct benefits to human physical health arising from use of and interaction with GS (e.g. Tyrväinen et al., 2005; Croucher et al., 2007; Pretty et al., 2007; Ward Thompson, 2011). Interestingly, some studies indicate that the benefits of outdoor GS are more substantial than those from indoor physical activity such as gyms and stationary bicycles with similar intensity (Pretty et al., 2005), which may be due to the greater positive psychological effect GS provide. Studies have also shown higher rates of healing when hospitalised with the presence of GS (Cooper-Marcus, 2005) and reduced mortality (Mitchell and Popham, 2008). Stress can produce physical symptoms such as headaches, pains and sore muscles, insomnia, and lead to colds or infections; Kaplan and colleagues (2007) noted that without exposure to GS humans suffer stress.

Psychological Benefits

A significant body of work by Rachel and Stephen Kaplan (1989) focused on attention restoration theory (ART) that provides evidence that GS not only reduce mental fatigue and stress, important components for human wellbeing and quality of life, but restore a person's capacity to pay attention, two critical components to effective human functioning in the modern world. Similar to ART, Hartig (2001) refers to 'mental restoration' as important for human wellbeing. Both of these concepts evolved from Ulrich's (1983) psychophysiological stress reduction framework (Korpela and Hartig, 1996; Kaplan, 2001).

A variety of GS have been shown to provide psychological benefits, including both naturalistic GS typologies as well as more anthropic ones. These include GS such as large and small forests (Park et al., 2011), wilderness spaces (Hartig, Mang, and Evans, 1991), rural areas (Roe and Aspinall, 2011), and prairies (Miles, Sullivan, and Kuo, 1998), as well as community parks (Fuller et al., 2007; Korpela et al., 2008), schools (Matsuoka, 2010), neighbourhoods (Ward

Thompson et al., 2012), and urban greenery (Taylor et al., 2002). Furthermore, studies report that, even without direct interaction, just seeing a GS can provide similar psychological and physical benefits (Ulrich, 1993, 1984; Maas et al., 2006).

Additional psychological benefits of GS interaction include recovery from stress (Aspinall et al., 2013), reduction in depression (Rappe and Kivela, 2005), reduction in both stress levels and ADHD in children (Wells and Evans, 2003), increased peacefulness and tranquillity (Jim and Chen, 2006), fewer reported stress related illnesses (Grahn and Stigsdotter, 2003) and reduced mortality (Berkman and Syme, 1979).

Social Benefits

Another important aspect of GS interaction is the social and socio-cultural benefits to HWB (Bell et al., 2008). This benefit is primarily met through an exchange or interaction between individuals or groups, often through communication such as talking, or gatherings such as picnics, games, etc. (Thomas, 2011).

Social ties among individuals, neighbours and members of groups are important to HWB (Chiesura, 2004). GS provide places for people to meet and develop social connections or social ties (Coley et al., 1997; Kuo et al., 1998, SNH, 2002). A study by Maas et al. (2009) found that, after adjustment for socio-economic and other demographic characteristics, less GS in the environment coincided with feelings of loneliness and with a perceived decrease in social support. Similarly, social safety is perceived as being increased with the presence of GS (Sullivan, 2005), excluding dense urban areas, where enclosed GS are associated with a lack of safety and security. Additionally, GS encourages a sense of community (Kim and Kaplan, 2004; Dinnie et al., 2013) and also offers spaces for outdoor education and learning (Bell et al., 2007). GS within children's play areas and schoolyards lead to more active and social play (Fjørtoft, 2004; Dyment and Bell, 2008). GS are also associated with higher levels of social contact and increased feelings of social support among neighbours (Kim and Kaplan, 2004; Maas et al., 2009).

GS provide opportunities where users can meet, talk, play, exercise and socialise. These GS create opportunities for people of all ages to interact, increasing social health (Walker 2004; Baycan-Levent et al. 2009) and providing a sense of connectedness (Peters et al., 2010), meaning and purpose, thus reducing depressive symptoms (Abada et al., 2007).

Another closely linked aspect of HWB within the social context is that of cultural benefits provided by GS. Cultural values are connections made with the landscape that are based upon prior experience such as family, upbringing and education (Tuan, 1974). Additionally, evidence shows that social interaction with varied age groups, cultures and ethnic backgrounds are more prevalent with the availability of GS (Kuo, Sullivan et al., 1998; Ward Thompson, 2002; Cohen et al., 2008), potentially leading to increased 'social cohesion' (OECD, 2011; Larsen 2013) and social inclusion (Gumplowicz, 1963; Parr, 2007; Rasidia et al., 2012). Community gardens are correlated with increased social interaction and improved social networks (Armstrong, 2000) as well as social cohesion[11] (Glover and Parry, 2005). Public parks allow for spontaneous interaction or the 'meeting of strangers' (Thompson, 1998, 2002; Walker 2004). Informal social contact with other individuals increases psychological and social wellbeing (Kweon, Sullivan and Wiley, 1998).

Social ties and a sense of community are also beneficial to groups of people and communities, not just individuals, providing 'social-control' within a GS which supports police monitoring for undesirable behaviour (Kuo, Sullivan, Coley, and Brunson, 1998). Weldon et al. (2007) support this capacity building aspect of green spaces, particularly among young people, noting increased public use can also lead to local stewardship and community-based maintenance. UGS has been shown to reduce negative social behaviour such as aggression and violence by instilling social cohesion and social identity (Dempsey, Brown, and Bramley, 2012).

This research seeks to establish relationships between the physical

[11] Social cohesion is defined as the he ties that bind humans together in society and have a large bearing on individual wellbeing and the wellbeing of the larger community (Putnam, 2000, Smith, 2003).

landscape, specifically GS, and HWB. In the context of PULs and PPUIGS, Figure 4.2 summarises the three distinct HWB dimensions and the corresponding benefits humans receive from interaction which were synthesised and adapted from the literature (e.g. Ryff and Keys, 1995; Gobster, 1998; Herzog and Chernick, 2000; Hitchmough and Calvert, 2002; Schalock and Verdugo, 2002; Wheeler and Betley, 2002; Morris, 2003; Gobster and Westphal, 2004; Seeland, 2004; Jorgensen, Bjerke et al., 2006;; Quality-of-Life Research Centre - Denmark, McCall, Rogerson, Cheisura, Villamagna, EEA, 2011; Cummins and Fagg, 2012):

Emotional Wellbeing (i.e. Psychological)
- Happiness - Sense of Enjoyment
- Contentment
- Comfortability
- Reduce Stress and Anxiety
- Serenity
- Sense of Fulfilment
- Self-esteem
- Relaxation and Tranquillity
- Feelings of Wellbeing

Physical Wellbeing
- Physical health and activities
- Leisure activities (rest activities)
- Safety
- Comfortability (level of comfort - heat, shade, air quality, noise, etc.)
- Reduce Fatigue (irritation, distress, aggression)

Social Wellbeing (i.e. Socio-Cultural)
- Community Integration and Participation (cultural interaction)
- Social Inclusion
- Appreciation
- Sense of Belonging
- Unity with Nature
- Social Support
- Cultural and Historical Heritage

Figure 4.2
Summary of HWB Benefits Received through Green Space Interaction

In summary, these wellbeing concepts and benefits span the spectrum of critical dimensions of HWB, QOL, and LS found within the human-nature relationships of GS (See Section 4.2). Although imperfections remain and

interrelatedness is overt, these serve the purpose of categorising the types of benefits and interaction with the PULs and PPUIGSs that affect HWB to the best degree possible.

4.6 PPUIGS Characteristics to Assess HWB and Ecological Integrity

Urbanising landscapes and their associated GS – under constant pressures and possessing unique characteristics that are neither urban nor natural – require a new and revised set of indicators to measure HWB, or welfare, better, both directly and indirectly. PULs provide a diverse set of functional uses for humans; both the biophysical and anthropocentric landscapes are driven by the landscape's structural characteristics, notably landscape fragmentation, that give it its form, processes and function (e.g. Sipilä & Tyrväinen, 2009).

This section answers:

- What are the specific physical characteristics of GS and PPUIGS that influence ecological integrity and HWB?;
- What specific wellbeing benefits do these green spaces and green structures provide?

Thus, this section analyses structural characteristics in order to determine what GS forms deliver what processes and are received for what ecological function and, simultaneously, human benefit through interaction. Current indicator models, however, capture only human or ecological aspects, not both simultaneously (Jongman, 2002; Dramstad et al., 2006; Farina, 2006).

Multiple disciplines have provided evidence of the relationship between GS and HWB utilising various indicators (Chan et al., 2012; Fagerholm et al., 2012; Tenberg et al., 2012; Satz et al., 2013), often exhibiting success, but none have also included the wellbeing of nature, or ecological integrity, within their models. There are not many integrated PUL characteristics and measures correlated to QOL or HWB in the literature, yet building on the work of Bell et al. (2007) and Jorgensen and Gobster (2010), this index (See Table 4.3) presents PPUIGS' characteristics, or aspects, specific to socio-cultural, psychological and physical HWB, as well as ecological integrity (i.e. ecosystem processes and functioning). Although this index

does not explicitly include the environmental or economic aspects of HWB, however, this research's approach does include this factor in its variable analysis (See Chapter 9), thus ensuring that comprehensive dimensions of HWB are accounted for.

Reflecting the concept of landscape services stated previously, this research's expanded model includes the distinct eco-spatial characteristics or structural qualities found within PULs and their GS that contribute to HWB that are often missing from traditional ES models. For instance, the index includes distinctly anthropocentric concepts of maintenance and management, facilities and accessibility, as well as the specific vegetation characteristics or 'greenness' that the literature has shown to affect HWB (See Section 4.5.3).

This research's PPUIGS Characteristics Performance Index (See Figure 4.3) is descriptive; it captures the qualities of the PPUIGS that provide landscape services. As a comprehensive index, it captures the current geomorphological state of the GS specific to research supported biocentric-indicators of landscape and GS fragmentation which are similarly research supported anthropocentric-indicators of GS interaction and HWB benefit provision.

The spatial mutuality between the biophysical structure and the anthropological structure found within PPUIGS characteristics facilitated the synthesis of indicators that combine multiple aspects of HWB – physical, psychological, social. A number of authors have noted the need to integrate ecological and human dimensions of wellbeing into one indicator or a composite of different indexes synthesised into an integrated indicator value (Gulinck and Wagendorp, 2002; Jongman, 2002; Dramstad et al., 2006; Farina, 2006). Although the concept of biodiversity has been put forth as a single, comprehensive indicator of human and ecological health or wellbeing, this simplistic measure denies the complex categorisation and mensuration implicit within this term's conceptual framework of DPSIR and landscape services.

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE
Size	*Area - Density - Largest*
Shape	*Regulation - Complexity & Diversity - Typology*
Proximity	*Nearest Neighbour - Isolation & Connectivity - Coherence*
Edge	*Total Edge - Longest Edge - Edge Density*
Accessibility	*Distance by Walk & Car/Bus - Access*
Greenness	*Composition - Setting - Structure - Density - Visibility - Slope - Proximity*
Maintenance & Management	*Cleanliness - Facilities - Sociability*
Safety	*Safety and Security*

Figure 4.3 - PPUIGS Characteristics Performance Index
PPUIGS Characteristics that Impact Landscape Services

Biophysical Characteristics of PPUIGS and HWB

The ecological component or biophysical structure aspects of the PPUIGS characteristics and attributes were developed through the lens of ecological integrity, which impacts the landscapes functional capacity primarily through its spatial arrangement (e.g. composition and configuration, heterogeneous vs. homogeneous – Turner, 1989; Bastian, 2001; Opdam et al., 2002) (See Section 3.3) of the PPUIGS. These biophysical aspects are assessed through the concept of ecological patch dynamics (e.g. ecosystem processes and functioning such as habitat, population, species diversity, disturbance, edge conditions, fractal dimensions, aggregation, heterogeneity, etc.) often represented in spatial ecology[12].

Importantly, these ecological-based characteristics were selected from established landscape ecology concepts that were specifically able to quantify the spatial condition and biophysical structure of landscape fragmentation. The PPUIGS characteristics reflect ecological integrity aspects and were selected from the various landscape fragmentation or spatial heterogeneity measures (e.g.

[12] Spatial ecology represents the quantification of the various spatial characteristics of landscapes or green spaces and provide quantitative studies with Landscape Ecological Metrics (Wu & Hobbs, 2007)

McGragil and Marks, 2002; Llausàs and Nogué, 2012) that are also components of spatial metric categories within FRAGSTAT GIS metrics or GIS spatial analyses (a component of this research, See Chapter 7). This research will not provide a thorough literature review of those structural relationships, literature is well versed in that aspect, and will only refer to concepts as needed.

For the sake of simplicity and efficacy, a core set of general landscape fragmentation characteristics or high-level indicators unique to PULs reflecting the current state of fragmented PPUIGS were chosen instead of a large selection of highly specific and often solely ecological-based indicators (as supported by Wascher, 2004).

The socio-cultural components or anthropological structural qualities of the PPUIGS' characteristics and attributes (e.g. Safety and Security, Maintenance and Management) were developed through the lens of HWB. The structural characteristics are assessed through the concept of physical – social – psychological wellbeing (e.g. recreation, mental health, social interaction, access and safety, ART, emotional/stress, complexity and variety, legibility, sense of 'naturalness', etc.) as described and measured through both objective and subjective attributes. As shown in Table 4.3, eight characteristics and their associated 25 attributes were selected. These are discussed in detail in the next section and in Figure 4.4.

4.6.1 PPUIGS Characteristics and Attributes in Detail

The objective of this section is to review a set of physical and structural PPUIGS characteristics and associated attributes that affect both ecological-based and human-based functioning (i.e. HWB) simultaneously, or landscape services. As argued by Lee and Maheswaran (2011), research must consider a broader range of factors to arrive at a better understanding of the causal mechanisms behind the multi-functional benefits and performance that GS yields. This section will answer:

- Do different PPUIGS characteristics play different roles with respect to ecological and HWB impacts and benefits?;
- How can these characteristics be measured within a peri-urban landscape context?

This section describes in detail those specific eco-spatial characteristics and their attributes as shown in Table 4.3 and Figure 4.4 - PPUIGS Characteristics Performance Measurement Index. It must be noted that these characteristics are specific to PPUIGS in Europe though some may be considered to apply to other types of GS as well such as IntGS and PUGS. As mentioned prior, the ecological benefits (i.e. ecological integrity aspects) are not discussed in detail as literature is well versed, but shall focus on the relationship to the anthropological aspects of physical, social and psychological HWB.

Characteristic #1 Size

Attributes ***Area - Density - Largest***

Size refers to the physical area of the green space (GS). Research has suggested that more benefits are afforded through larger GS (Mitchell et al., 2011). Various sizes provide different benefits. Larger GS are likely to be used for physical benefits, whereas smaller GS have been reported to provide spaces for 'rest' and 'socializing' (Peschardt et al., 2012).

The Vitamin G project provided evidence that the overall amount of GS within the landscape, the density of GS, improves HWB through direct exposure (Groenewegn et al., 2006). Research has reported that the percentage of GS in people's living environment had a positive association with the local resident's sense of HWB (Maas et al., 2006; Groenewegen et al. (2006; Gable and Haidt, 2005). Coles and Caserio (2011) noted that larger GS act as a buffer to more urban environments, facilitating health and psychological benefits. Sizing criteria is abundant in the ecological sciences, however for humans, Coles & Bussey (2000) found that an area of two hectares was the minimum size of woodlands that people would choose to visit regularly.

The size of the GS influences many other attributes such as connectivity, complexity, accessibility, and density. Density refers to the concentration of GS within the given area of study. The overall density, or percentage of GS within an area, impacts its accessibility (See below) and the many benefits afforded. Literature has suggested there are adverse mental health consequences resulting from an absence of GS in the landscape. After allowing for demographic and socio-

economic characteristics, a study in Holland found that the prevalence of depression and anxiety was significantly greater for those living in areas with only 10% GS in their surroundings compared to those with 90% GS (Maas et al., 2009).

Characteristic #2 Shape

Attributes ***Regulation - Complexity & Diversity - Typology***

The complexity and diversity of a GS influence both ecological function and visual character (Forman and Godron, 1986; Tveit et al., 2006). Complexity and diversity, as well as many other characteristics discussed herein, impact HWB through the concept of coherence. Though coherence is predominately used in perception and aesthetic discourses (i.e. visual coherence: Kaplan and Kaplan, 1989), in this context, the term refers to a lack of physical and spatial disturbance such as spatial continuity and physical similarities in vegetation and materials (Tveit et al., 2006) and a sense of physical connectedness to other GS, which is reduced by fragmentation. Coherence also includes the physical relationship between landscape settings and typologies, such as those described in the urban-rural gradient (See Figure 3.2); abrupt edges between GS types and characteristics reduce GS coherence. Coherence can also refer to lack of contextual 'fit' (Bell, 1993). A lack of landscape coherence, reflecting a higher level of physical disturbance, influences HWB through stress and reduced mental restoration capacity (Kellert, 1996).

Complexity refers to the diversity and richness of landscape elements or GS and their interspersion or patterns in the landscape. This characteristic did not distinctly evaluate visual complexity, which provides many indirect benefits to HWB such as mysteriousness, variety, legibility, and visual stress (e.g. Kaplan, 1989; Ulrich and Parsons, 1992). However, the concept of visual complexity is inclusive in the overall model.

'Complex' and 'fascinating' GS furnishes humans with opportunities to explore and restore their mental acuity (Kaplan and Kaplan, 1989), important for HWB. A GS's shape and overall pattern complexity influences the visual character of the GS and region as well as edge characteristics. Diversity in the spatial

planning disciplines is defined as the variety of experience from places with varied forms, uses and qualities. It is the types of, scale of, and distribution of GS elements and/or their characteristics and attributes which provide diversity in the landscape. Diversity - applied to land uses - may refer to residential and commercial spaces providing a diversity of liveliness.

Diversity of GS influences HWB, the amount and distribution of GS within the region provides access to and interaction with a variety of GS types and benefits. For instance, van Dillen et al. (2012) as well as Kaczynski, Potwarka, and Saelens (2008) reported that more formal GS typologies often includes features and facilities that promote physical or social activity, such as well-maintained paths and safety features. Alternatively, those GS with more 'natural' characteristics (e.g. trees, water, more degree of wilderness, less maintenance) increase benefits such as stress reduction. Humans find more visual stress reduction from GS that *"isn't either too diverse or too monotonous"* (Kaplan, 1989). The availability of natural open space has been shown to promote social interaction and increase sense of community (Kim and Kaplan, 2004). Mazlina et al. (2012) noted that GS provide health benefits through physical, leisure and social activities that lead to physical, cognitive and social wellbeing; they also suggested that a diversity of GS is required in order to achieve those benefits.

The characteristic and attribute of 'Natural' requires specificity in its description and context of this research. A natural landscape is a landscape that is unaffected by human activity. A natural landscape is intact when all living and nonliving elements are free to move and change. The nonliving elements distinguish a natural landscape from a wilderness. A wilderness includes areas within which natural processes operate without human interference, but a wilderness must contain life. Comparatively, it is dissimilar to an urban or human-affected landscape (e.g. anthropocentric landscape or human-modified landscape) which contain many human-based elements such as builidngs, infrastructure and other urbane elments.

Natural landscapes, thus may considered those undisturbed landscapes, often similar to wilderness and less managed (e.g. forestry and agricultural

practices) than the more urban landscapes. Figure 4.3A illustrates a Natural, Semi-Natural and Urban landscape as defined in Figure 4.4. Terms often associated with natural landscapes are less formal, less manicured, loose, wild, informal, simple landforms and elements or features (See Chapter 2) such as mountains, hills, lakes, streams, rocks, and animals.







Figure 4.3A
Natural (top) Semi-Natural (middle) and Urban (bottom) Landscapes within Paisley, Scotland

A common analytical technique utilised in many disciplines is to determine a GS's typology, often whether it is 'natural' or 'urban'. There are many spatial and aspatial characteristics that can be used in a typological analysis, often determined by the scale and geographic context as well as socio-cultural influences. Though this indicator and its attributes/characteristics do not capture all the aspects of knowledge regarding the concept of GS typology that can inform research and relational insight, other indicators within this model add to the overall quality of a GS.

The concept of typology in this characteristic-model context is similar to the urban-rural transect model (Figure 3.1). Natural GS contain many vegetation elements and few 'built' spaces; non-natural or urban GS are considered 'built' spaces. Characteristics of these 'built' spaces include concrete and other built

structures, asphalt roadways, a predominance of structures and facilities, and a general lack of vegetation.

Characteristic #3 Proximity

Attributes ***Nearest Neighbour - Isolation & Connectivity - Coherence***

The spatial distribution of GS impacts visitation and use. This characteristic does not discuss a GS's proximity or physical distance to an individual or within the context of accessibility to a GS (See Indicator #5), but rather, specifically, the eco-spatial and structural connectivity of a GS. The closeness and proximity of a particular GS to another GS is important not only ecologically but to provide means of safe and enjoyable access and use for humans. Connected GS increases the relative size and distribution of GS within an area. Physically connected GS provides for more active or physical benefits as they are often connected through linear paths or 'green corridors'.

One of the main characteristic differences between peri-urban GS and their non-urban counterparts is that they are generally more fragmented (Hanski, 1999, Niemelä, 2001). Connectivity is an established landscape ecological term, sometimes referred to as 'functional connectivity'. In this research, connectivity refers to the physical and spatial patterns of GS within the landscape. Similarly, the concept of coherence is based upon spatial connectivity but accounts for GS features or elements, such as a football pitch, village green, or picnic area, found within a larger landscape setting or even GS.

Characteristic #4 Edge

Attributes ***Total Edge - Longest Edge - Edge Density***

The eco-spatial characteristic of edges is well documented within landscape ecology and ecological integrity dialogue. However, very little research has included this characteristic when discussing HWB. Edges are simply the borders of margins, where a particular GS begins or ends or where a transition takes place between two areas. Evolving from experiential landscape principles, spatial edges help define human-space from nature-space, often creating transitional edges.

Transitional edges are coherent socio-spatial domains facilitating a sense of appropriateness and not simply boundaries between the ownership [13]. Edges, together with GS and the spatial forms found within the peri-urban landscape, create distinguishable space that allow for distinct empirical analysis.

Edge characteristics impact visibility and the degree of visual penetration of vegetation (Weinstoerffer and Girardin, 2000) and depth of view (Gulinck et al., 1999). The level of safety and security within a GS is significantly affected by its edges; open and visible edges - as well as high visibility within a GS - and a lack of dark areas are important for a visitor's sense of 'eyes-on' safety. Wright et al. (1996) concluded that vegetated edges promote exercise. Indirect HWB benefits include the cleaning air effects and noise abatement linear rows of trees and hedgerows provide. Overall, edge characteristics overlap with many others discussed herein such as shape, typology, level of greenness, etc. For example, a study by Pikora et al. (2003) suggested that walking in a neighborhood is increased when there are views available. Additionally, active use of GS may also be increased when paths have a vegetated border that allow wide views (Giles-Corti et al., 2005).

A literature search (2016) produced very little academic publications concerning edge effects within urban landscapes, though much exists for fragmentation, none specific to edge effects. The edge effect upon humans and HWB beyond ecosystem services is an important concept to research and is lacking.

Characteristic #5 Accessibility

Attributes ***Distance (and access by Walk & access by Car/Bus/Tram)***

Accessibility is defined as the ability of individuals or groups to get to the GS. Accessibility or physical distance to a GS is a key factor in facilitating GS

[13] For more information on experiential landscape and creating places from space, see Habraken's framework of form (structurally stable framework), place (processes of occupation) and understanding (expressions of individual and community ownership) as three inter-related influences on the structure of the ordinary built environment (Habraken, 1998).

interaction and use (Coles and Bussey, 2000; Giles-Corti et al., 2005; Grahn and Stigsdotter, 2003; Nielsen and Hansen, 2006). HWB benefits can only be received if they are accessed, which means they are available (van Dillen et al., 2012). A GS's distribution within the region and proximity to an individual's home was found to be significant in predicting whether people visit GS (Ward Thompson, 2002; Rosso et al., 2011; Neuvonen et al., 2007) as was the level of maintenance, cleanliness, and safety (Hartig et al., 2011). People who live closer to a park or trail will visit it, on average, more often than those who live further away (Hoehner et al. 2005).

Accessibility to a GS in urban and peri-urban areas is often related to the means of transportation available to reach the GS (Iamatrakul et al., 2005). Depending on one's availability (e.g. work and family commitments, weekends vs. weekdays), most individuals are restricted to those nearby GS to interact with during weekdays. Community cohesion increases with increased accessibility (Seaman et al., 2010). Additionally, access to GS provides important interactions for children, families with small children, elderly people in cities (Maas et al. 2005), and the disabled (Lundell 2005).

Research has demonstrateed that access to GS increases physical health (Maas et al., 2006; Thompson and Aspinall, 2011), social cohesion (Fuller et al., 2007; de Vries et al., 2008) and mental wellbeing (Maas et al., 2009). Lopez and Hynes (2006) found that individuals living close to parks are more likely to use them and be physically active than those who live farther away. Sallis et al. (1998) found that physical activity within parks was correlated to its convenience or proximity to access Similarly, Troped et al. (2001) reported that the closer people lived to bike trails, the more likely they were to use them. Overall, people who live closer to a park or trail tend to use them more frequently, on average, than people who live farther from the GS (Hoehner et al., 2005). Yet, Kaczynski et al. (2008) published that distance from home was not a significant predictor of the use of neighborhood parks for physical activity.

A study in Helsinki, Finland, showed that a moderate to high density of green areas and those within a short distance of access to a recreational space

increased the number and frequency of visits (Neuvonen et al., 2007). GS use and access at a close-to-home quality may increase other GS typology use as well (Grahn and Stigsdotter, 2003; van Herzele and Wiedeman, 2003). Other research noted that though access was an important component to a sense of HWB, just the knowledge of nearby nature and GS added to one's HWB (Bell et al., 2004).

Characteristic #6 Level of Greenness - Vegetation Structure

Attributes ***Composition - Setting – Structure***

The 'greenness' of a GS is delineated by a series of characteristics. The level of greenness is closely related to a common term in literature – level of naturalness. Naturalness is referred to as the similarity of a particular landscape or GS to those conditions of one with little direct or indirect human impact. The visual aspect of greenness includes qualities of complexity, composition found within its vegetation structure, and density. Much literature exists on the level of naturalness or greenness within GS as a factor that impacts HWB (e.g. Stigsdotter and Grahn, 2011; Thompson and Apinsall, 2011; Gable and Haidt, 2005) as well as ecological integrity or biodiversity (e.g. Sandstrom et al., 2006).

Interaction with more 'natural' environments has shown to reduce stress levels (Bolund and Hunhammar, 1999; Grahn and Stigsdotter, 2003), however, individuals often noted the benefit of the presence of some man-made features, especially for achieving a sense of history, for a feeling of community, or for providing accessibility to the landscape (Natural England, 2009).

King et al. (2000) found that those GS that possessed green, naturalistic-vegetated hills have been associated positively with physical activity among females in different socio-economic groups in the US. O'Brien and colleagues (2014) suggested that HWB benefits afforded from trees and woodlands were due to their distinct scale particularly when compared to other vegetation types of flora, habitats, and GS. They also reported woodlands and large trees in particular carry cultural meanings, many of which were identified as being significant in relation to their perceived health wellbeing. This same study also reported that the other individual wellbeing benefits gained from engaging with peri-urban woodlands

included improved mental and psychological wellbeing, reducied stress, and other social benefits such as volunteering and social connectivity when including family and friends.

Characteristic #7 Level of Greenness - Vegetation Density

Attributes ***Density - Visibility - Proximity to Road***

Vegetation density is another common ecological term known to impact ecological integrity and processes (Raupach et al., 1996; Katul et al., 1998). Mitchell and Popham (2008) found that populations exposed to the greenest environments had the lowest levels of health-related mortality issues. Well-vegetated landscapes have been shown to improve not only the QOL in neighbourhoods but also improve the physical and emotional health of residents (Attwell, 2000).

In low-rise urban housing developments, it was reported that GS with more 'greenness' to them were used more for individual activity and social interaction (Sullivan et al., 2004). Social integration has been shown to increase with a high level of greenness and diversity in vegetation (Coley, Kuo et al., 1997; Sullivan, Kuo et al., 2004). Kuo et al (1998) correlated that more trees create a safer environment for users, however multiple studies correlate more trees to feelings of insecurity, leading to the conclusion that this is a contextual quality.

Both vegetation density and edge conditions impact HWB as they reduce traffic noise and pollution (Lafortezza et al. 2009; Tong and Ding 2011). Open GS and landscapes increase overview and visibility that impacts HWB (Kaplan and Kaplan, 1989; Zube, 1984), allowing the feeling of 'escapism' if confronted by danger. Open GS provide long views and visual complexity. Enclosed GS produce threatening and unsafe feelings. However, woodland and hedges create a sense of enclosure and security, and also adds variety and complexity to the GS. GS with areas of enclosure provide opportunities for individuals to find peace and quite as it shields them from exterior noise and observation.

Peace and quiet can be difficult to find for those GS located close to heavy traffic roads, industrial facilities, power generators, or other structural influences. The HWB benefits found within GS can be adversely influenced by such factors.

Characteristic #8 Maintenance and Management

Attributes ***Cleanliness - Facilities***

Maintenance and management refers to the specific GS conditions and qualities such as its vegetation, facilities and features, overall structure, messiness/cleanliness, levels of naturalness, and aesthetics. These characteristics are closely tied to Indicator # 6 and others as the maintenance and management directly influences the structural and physical characteristics of the GS – a highly maintained GS might exhibit more urban qualities whereas a less maintained GS would offer more 'natural' qualities.

The management and maintenance qualities of a GS influence many ecological processes (e.g. Andersson et al., 2007; Fuller et al., 2007) and, directly and indirectly, HWB. For instance, poorly maintained GS with overgrown vegetation and poorly maintained facilities negatively influence an individual's sense of safety and psychological wellbeing (ibid). Poorly maintained elements such as entrances and gates, signs, vegetation and grass, fences and pathways present physical obstacles for users. Poorly managed GS are thought to incite antisocial behavior or vandalism (Woodland Trust, 2002; Brownson et al., 2001) and often include dangerous features such as broken equipment or glass, hazardous trees, and disused drug paraphernalia (Lee et al., 2005). Examples of antisocial behavior and actions include vandalism and graffiti, litter and fly-tipping, dog fouling and uncontrolled dogs, and the dumping of cars, motorbikes and refrigerators. Poorly maintained GS do not provide for recreational use due to a lack of confidence in one's safety. For instance, Ellaway et al. (2005) noted that higher levels of greenness and maintenance quality in residential areas promote physical activity and health benefits. Alternatively, the presence of litter and debris, as well as the absence of maintenance, could be detractors to GS use (Carnegie et al., 2002).

In a study of preferences, residents selected GS that had a certain level of maintenance ('cleaner looking') (Nassauer et al., 2001) and accessibility (Todorova et al., 2004). Well-maintained grass areas and well-formed trees increase a sense of safety (Nassauer, 1995).

GS facilities represent a variety of elements, structures and even programs that attract different users. Some people seek out certain GS facilities to achieve certain HWB benefits through specific actions such as those with sportsfields and swimming pools (Humpel et al., 2004; Cohen et al., 2006) or picnic benches and flowering gardens. According to Kaczynski et al. (2008), park facilities are more important than park amenities and trails and have the strongest relationship with physical activity. The more 'passive use' GS were characterised by the presence of lawn areas, trees, water features, lakes, picnic areas, and/or walking trails (Mertes and Hall, 1996).

The facilities present in a GS directly influence use and interaction; those GS with a diversity of clean and well maintained features and elements such as ponds and fountains, encourage higher levels of use (Giles-Corti et al., 2005). Similarly, Leyden, Goldberg, and Michelbach (2011) reported that GS with cultural facilities and amenities increase an individual's level of happiness. Jorgensen et al. (2007) concluded that, in the context of gardens found within parks and private gardens, that those with higher levels of maintenance led to a more positive appraisal of the quality of the community.

Amenity-oriented greens, such as dog parks, add another level of diversity to a GS. Drawing on findings that walking with a dog provides health benefits for humans, and *"can facilitate social interactions among people"*, Christian, Giles-Corti, and Knuiman (2010) determined that dog owners are more physically active than non-owners (p. 44). Natural England (2009) reported that beaches and woodlands/forests added significant HWB benfits.

Characteristic #9 Features

Attributes *Facilities (Sociability & Paths)*

The sociability of a GS is exemplified by its provision for different user groups and uses. These include designated dog spaces, children's play areas, game tables, benches and seating, covered areas, tables, and others. Highly sociable GS provide large group gathering areas as well as a variety of spaces for formal and informal gathering and socialising. Additionally, GS can accommodate a range of user group sizes including single people (1), small groups (2-4), families (3-10), and a large group (>10). Both solitary and isolated spaces as well as exposed and communal spaces and facilities impact the sociability of a GS. Literature has also indicated social ties are engaged and strengthened through social activities within GS (Kazmierczak and Carter, 2010). Physical activity can be increased when individuals feel interpersonally confident; social networks encourage the development of this conviction (McKendry, 2008).

GS facilities include a variety of elements, structures, amenities, and programs that afford benefits to a variety of users and uses. These include benches, tables, paved areas, toilets, lighting, drinking fountain, signage, cafe, bins, footpaths, sheltered areas, and others. This characteristic did not include organised sport activities such as sport fields, swimming pools, etc. The various facilities present in GS affect the social factors that serve a role in determining the accessibility and use of parks (Bedimo-Rung et al., 2006; Haq, 2011).

Kaczynski et al. (2008) noted that park facilities are more important than park amenities and trails have the strongest correspondence with use for physical activity. GS of many typologies were stated by Georg Simmel to serve as 'everyday social settings' (Lechner, 1991) which include casual interaction afforded through such local features as street markets, parks, residential squares, sitting-out areas and canal-side walks, or journeys on foot to a school or workplace, to perceptions of inclusion and a sense of community (Cattell and Herring, 2002).

The design and maintenance of path and trail networks within GS and linking GS to home locations is important to encouraging their use. Lindsey et al. (2008) found that the trail characteristics and urban greenway attributes which received the most use were those that offered wide paths, open views, higher diversity, and higher levels of greenness than the surrounding area.In the same

study a negative correlation between use and unpaved paths was found. This finding was supported by van Lenthe et al. (2004) which reported that poor trail and path conditions led to physical inactivity. Additionally, user conflicts arise on shared-use paths; walkers and runners reported deceased enjoyment when sharing with skaters and bikers (Moore et al., 1998).

Socially, having contact with your neighbours and engagement in social activities increases psychological satisfaction and reduces unhappiness (McAuley et al., 2000). Social ties have shown to reduce certain adverse health conditions (Lindheim and Syme, 1983). One recent study identified 'social cohesion' within informal social settings of parks and found that those GS with higher social facilities and features received more than four times the use than those with less facilities (Broyles et al., 2011). This study also also found that GS with more social facilities and elements received visitors from further distances. Additonally, Neuvonen et al. (2007) stated that the social context influences participation in recreational activities; an individual is more likely to participate in an outdoor physical activity if his or her family also do. Lastly, community gardens have shown to facilitate social interaction (Comstock et al., 2010).

Characteristic #10 Level of Safety

Attributes ***Safety and Security***

Both real and perceived safety is an important factor affecting the use of GS (Herzog and Chernick, 2000). Unsafe and unsecure GS may have broken or inadequate lighting, broken locks or gates, poorly maintained or damaged facilities and amenities, insufficient or deficient fencing, hedge, and/or wall treatments, and poorly maintained or inappropriate vegetation types.There may also be safety and security aspects within the surrounding environment and landscape (e.g. crime rate, depravity, upkeep) influencing use. Kirtland et al. (2003) reported that those individuals more concerned with safety and security issues were less likely to interact with the GS. This is supported by Suminski et al. (2005) who noted that neighbourhood safety is an important factor of walking.

In peri-urban GS, many 'wild' characteristics persist such as dense and unmanaged vegetation and larger more expansive spaces. The fear of nature and the wildness[14] and unpredictability of nature is a human tendency. Studies have shown that individuals have a fear of darkness, dangerous people, and wild animals such as snakes and insects within peri-urban GS (Blomqvist, 2003; Herzog and Chernick, 2000).

The first basic psychological need that Kasser et al. (2004) identify is the need for a sense of security, safety and sustenance; it is an instinct to stay alive. Food and shelter access provide this as does staying away from unstable, dangerous and anxiety-provoking situations. Supporting Kasser, Deci and Ryan (2000) propose that people need to feel a degree of autonomy[15], competence, and relatedness[16] in order to have a continued sense of integrity and wellbeing. Feeling 'authentically engaged' in our behaviour increases our wellbeing (Kasser 2002). Competence refers to the experience of one's behaviour being effective (Deci and Ryan 1985). That is to say, that one is generally capable of reaching the effect one was hoping their behaviour would have.

Maintenance aspects are closely linked with safety aspects. Research and conclusions drawn from visitor studies have pointed out that people avoid GS that are neglected. A sense of insecurity reduces the QOL of the perceiver, and safety and security are important factors for wellbeing (Johansson, 1979). GS with low safety and security characteristics are simply avoided and not interacted with (Koskela and Pain, 2000). The presence of criminal activity such as the sale and use of drugs deters GS interaction (Gobster, 1999; Outley and Floyd, 2002).

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[14] Often, the sense of wildness is evaluated through contrast. The contrast between wild natural vegetation and regular anthropological patterns of vegetation corresponds to the symbolic contrast between nature and culture. See "New Wilderness" as an Element of the Peri- Urban Landscape" by Sigurd Karl Henne (2005).

[15] Evolving from self-determination theory (SDT, Deci and Ryan, 1985), autonomy here refers to self-endorsed motivation. Having the freedom to act on one's own feelings and ideas, rather than being commanded by external actors (Ryan and Deci, 2006).

[16] Relatedness refers to one's connections with other people. These connections include relatives, friends, and larger groups.

4.6.2 Landscape Structure and Green Space Characteristics

This research's operationalised PPUIGS Characteristics Performance Measurement Index - Figure 4.4 - builds upon the PPUIGS Characteristics Performance Index shown in Figure 4.3. These Indices focus on landscape services and landscape performance – both biophysical based (e.g. ecological integrity, patch dynamics) and anthropological based (e.g. QOL, HWB) - to better comprehend the complex and dynamic relationship found within the fragmented, polycentric PULs between humans and nature. This index simply provides the descriptive and evaluative values or measures to collect data and assess the current fragmented, eco-spatial state of the PPUIGS (See Chapter 7).

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	SOCIO-ECOLOGICAL PPUIGS ASPECT (Levels of Measurement)
SIZE	AREA	**Extensive** - green structure separates houses well, not see other houses within green structure or at green structure edges **Moderate** - green structure separates houses somewhat **Limited** - from green structure edge, one can see houses across from them
SIZE	DENSITY	**High Density** - green structure is seen nearby **Moderate Density** - green structure is seen at a distance but not nearby **Low Density** - green structure is not seen at all
SIZE	LARGEST	**Largest** - green structure is very large and is the largest (>75%) in the catchment area **Moderate** - green structure is normal sized when compared to others (in CA)(25%-75%) **Small** - green structure is very small and is the smallest (<25%) in the catchment area
SHAPE	SHAPE - REGULATION	**Regular** - green structure is regularly shaped with mostly evenly-spaced and/or evenly-lengthed sides (rectangle, square, or mostly equilateral polygon - a circle or semi-circle is considered regular) **Moderate** - green structure is somewhat regularly shaped and, overall, most parts are regularly and evenly shaped with a few angled corners and possibly some linear and narrow portions. **Irregular** - green structure is not regularly shaped with many uniquely-angled corners and very few if any any similarly-spaced or similarly-lengthed sides **Linear** - green structure is considered a linear corridor such as a national bike path or river walkway
SHAPE	COMPLEXITY and DIVERSITY	**Complex** - green structure is complex and diverse in shape. There are many sides (8+) and unique angles (e.g. 0-30deg, 110deg+) **Moderate** - green structure is neither complex nor simple in shape (4-8 sides). Somewhat regularly shaped. **Simple** - green structure is simple and uniform in shape (3-4 sides). It is very regularly shaped. **Linear** - the green structure is a linear corridor with a few larger areas (parking, amenities) along route.
SHAPE	TYPOLOGY	*If the green structure has a mixed spatial quality to it, the dominant portion or most used portion determines level* **Natural** - green structure feels wild and natural, sense of ruralness to it (e.g. Woodlands) **Moderate** - green structure feels neither natural or urban (e.g. Agricutlural and Grazing lands) **Urban** - green structure feels urban, not very natural or rural at all (e.g. Playing Fields, Civic Plaza, Monument)

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	SOCIO-ECOLOGICAL PPUIGS ASPECT (Levels of Measurement)
PROXIMITY	NEAREST NEIGHBOUR	**Connected** - green structure is physically connected to another at least 1 side (no street, wall, fence - path ok) **Nearby** - one can see another green structure (50m minimum width facing) from most parts of the green structure, but not physically connected. A street, rail or wall/fence may separate the green structure. **Separated** - green structure is alone & separate, not physically or visually connected, cannot see another green structure from any parts of green structure
PROXIMITY	ISOLATION and CONNECTIVITY	*When viewed without land ownership boundaries:* **Grouped** - considered 1 in a group of many green structures nearby **Moderate** - considered 1 in a group of few green structures nearby **Isolated** - only green structure, none in nearby group
PROXIMITY	COHERENCE	*Level of Coherence* **Integrated** - green structure is part of bigger, physically and spatially (e.g. garden within housing, village green within neighbourhood, playground within larger park) or area within larger green structure (e.g. Regional or Country Park) **Autonomous** - green structure sits independently - by itself - and is autonomous and not part of a bigger park (e.g. Regional or Country Park) **Linear Corridor** (river walk, bicycle route, etc).
EDGE	TOTAL EDGE (Quantity)	**Numerous** - green structure has many edges (8+) **Moderate** - green structure has a moderate amount of edges (4-8) **Few** - green structure has few edges (3-4)
EDGE	LONGEST EDGE (Length)	**Longest** - green structure has some or a very long edge, longest in area **Moderate** - green structure has normal edge sizes when compared to others **Least** - green structure has some or a very short edge, shortest in area
EDGE	EDGE DENSITY (Vegetation or Structures)	*Edge Condition can be vegetation (trees, shrubs) and/or built structures (fence, wall, houses, etc)* **Dense** - dense edges, not very visible into green structure, blocks views into green structure **Moderate** - some edge areas offer visibility into green structure **Transparent** - very open edges, easily visible into green structure from outside-in or inside-out

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	SOCIO-ECOLOGICAL PPUIGS ASPECT (Levels of Measurement)
ACCESSIBILITY	DISTANCE (WALK)	*For nearby neighbourhood(s):* **Close** - getting to the green structure requires a short walk (0-5 min or 0-400 m) **Moderate** - getting to the green structure requires a long walk (5-10 min or 400 - 800m) or bike **Far** - getting to the green structureGS requires a car or bus (over 10 minutes, over 800m)
ACCESSIBILITY	DISTANCE (CAR/BUS)	*For nearby neighbourhood(s):* **Close** - getting to the green structure requires a short vehicular ride (0-2 km) **Moderate** - getting to the green structure requires a moderate ride (2-5 km) **Far** - getting to the green structure requires a long vehicular ride (5+km)
ACCESSIBILITY	DISTANCE (LEVELS OF)	**Full Access** - entry to the green structure is possible without restriction. **Conditional Access** - a right of entry exists which is subject to or affected by one or more restrictions or conditions (e.g. hours, pass requirements, permitted use restrictions, etc) **Remote Access** - no physical right of access exists (e.g. gates, fence, wall), but the green structure provides a visual green resource whether viewed close or at a distance
GREENESS	VEGETATION COMPOSITION	**Deciduous** - green structure with predominately deciduous vegetation types **Evergreen** - green structure with predominately evergreen vegetation types **Mixed** - green structure with a fair mixture of different (evergreen and deciduous) vegetation types green structure **Play fields or Grass** - green structure which is a playing field or a grass area (including grazing and agricultural or farming fields)

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	SOCIO-ECOLOGICAL PPUIGS ASPECT (Levels of Measurement)
GREENESS	VEGETATION COMPOSITION - SETTING *(May have 1 or more of the following:)*	*Regardless of facilities or amenities including paths, lights, bins, benches, centres, toilets:* **Natural** - green structure is very natural and has no informal recreation opportunities (beyond trail walking, wildlife viewing, etc), a wide variety of vegetation types and/or types of habitats and with predominately natural or naturalistic vegetation. Green structure lacks a formal composition and may have a 'wild' feeling to it. **Semi-Natural** - green structure still has a natural feeling to it and a few informal recreation opportunities (beyond trail walking, wildlife viewing, etc) with a variety of vegetation types or limited types of habitats and with some natural or naturalistic vegetation or areas. Agricultural Fields and Grazing Lands are often considered of this Setting. **Semi-Urban** - green structure has a few informal and at least one formal recreation area. There is a good mixture of both formal and informal plantings and habitat or vegetation types. Some large, manicured grassed areas. **Urban** - green structure has mostly formal recreation opportunities. Vegetation types may be varied but are managed heavily and/or predominately ornamental vegetation varieties. There may be many formalised, manicured grassed areas. There may be many formal plantings. Play fields are often considered of this Setting.
GREENESS	VEGETATION STRUCTURE - HORIZONTAL *(not dependent upon vegetative composition)*	*Deciduous and/or Coniferous Vegetation Types, Vertical is under 4' height:* **Diverse and Random** - green structure with many different horizontal vegetation types whose diversity is visually dominant. Distribution is many and informal/wild. **Clustered** - a few or many different horizontal vegetation types, but not present in all areas of green structure. Horizontal vegetation is distributed only in clumps or massed planting areas. **Uniform** - green structure with hardly any or different horizontal vegetation types (e.g. play fields, mown grass parks). Little horizontal vegetation distribution within GS.
GREENESS	VEGETATION STRUCTURE - VERTICAL *(not dependent upon vegetative composition)*	*Deciduous and/or Coniferous Vegetation Types, Vertical is over 4' height:* **Diverse and Random** - green structure with many different vertical vegetation types whose diversity is visually dominant. Distribution is many and informal/wild. **Clustered** - a few or many different vertical vegetation types, but not present in all areas of green structure. Vertical vegetation is distributed only in clumps or massed areas. **Uniform** - green structure with hardly any or different vertical vegetation types (e.g. allees, walkways). Little vertical vegetation distribution within green structure (many open spaces). None visually dominant.

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	SOCIO-ECOLOGICAL PPUIGS ASPECT (Levels of Measurement)
GREENESS	VEGETATION STRUCTURE - DENSITY *(not dependent upon vegetative composition)*	*Deciduous, Mixed and Coniferous Vegetation, Horizontal and Vertical, Considered Spatially:* **Dense** - within green structure, many dense or clustered plantings, crowded and tightly-packed. **Moderate** - within green structure, both dense and sparse areas **Open** - within green structure, sparse plantings, few plantings, spacious (mostly grass areas, play fields).
GREENESS	VEGETATION STRUCTURE - VISIBILITY	**Extensive** - within green structure, many (3+) long and expansive views, within green structure and/or out from green structure **Moderate** - within green structure, a few (1-3) extensive views, some areas with limited visibility **Limited** - within green structure, no long or expansive views either within green structure or out from green structure, limited visibility
GREENESS	PROXIMITY TO HEAVY TRAFFIC ROAD	**Close** - the green structure is directly adjacent to heavy traffic road (M, A or 4-Lane Road) **Moderate** - one can see or hear traffic road within green structure (M, A, B or 4-Lane Road) **Far** - no heavy traffic road in in visual or aural proximity of green structure
MAINTENANCE AND MANAGEMENT	CLEANLINESS	**Clean** - green structure is well maintained or managed. Pavement is not cracked, vegetation is trimmed, grass is mowed often. Not many exposed dirt areas, no dog fouling. No graffiti or rubbish seen outside bins. Benches are clean and sturdy. 'Tidy' green structure. **Moderate** - green structure adequately maintained, some dirty areas. **Dirty** - green structure not well maintained or managed, messy. Pavement cracking and limited grass and vegetation maintenance. If present, buildings and structures/amenities not well maintained or clean. Rubbish and graffiti may be seen. Not a 'Tidy' green structure.
MAINTENANCE AND MANAGEMENT	FACILITIES (AMENITIES)	**Abundant** - green structure has many facilities and/or user amenities (e.g. benches, tables, paved areas, toilets, drinking fountain, signage, cafe, bins, etc) throughout. **Adequate** - green structure has a good amount of facilities and/or user amenities **Inadequate** - green structure has few facilities and/or user amenities
MAINTENANCE AND MANAGEMENT	FACILITIES (PATHS)	*NOT quality of pavement or paths, not maintenance level - only provision of paths:* **Paved** - nearly all paths are paved (non-porous) **Mixed** - some non-paved trails and walking tracks & some paved paths and walking/cycling areas **Unpaved** - no paved paths or trails

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	SOCIO-ECOLOGICAL PPUIGS ASPECT (Levels of Measurement)
MAINTENANCE AND MANAGEMENT	FACILITIES (SOCIABILITY)	**High** - the green structure has exposed spaces with many places for social interaction, both formal & informal. There is a designated dog space. Many benches and seating areas, possibility of a playground or communal area. green structure can accommodate large groups. **Mixed** - the green structure has both exposed and communal spaces and more solitary and alone spaces. Not many communal areas but still some spaces for large groups. **Low** - the green structure has mostly solitary and isolated spaces. Not many benches or tables.
SAFETY AND SECURITY	SAFETY and SECURITY	*Presence of lighting, locked gates, open edges, visibility/eyes-on, management:* **Safe** - many lights and open edges, visibility within and throughout is high. **Somewhat Safe** - some lights and/or some edges are open. Visibility is acceptable at some places. **Unsafe** - minimal or no lights, enclosed and dark edges, low visibility. Many dark areas.

Figure 4.4
PPUIGS Characteristics Performance Measurement Index
Index and Measurement Levels for Assessing PPUIGS Characteristics that Impact Landscape Services

The spatial mutuality between the biophysical structure and the anthropological structure found within PPUIGS characteristics facilitated the synthesis of indicators. Though ecological integrity is considered a nested hierarchy (e.g. Noss, 1990), for the sake of simplicity and efficacy, a core set of general landscape fragmentation characteristics or high-level indicators unique to PULs reflecting the current state of fragmented PPUIGS were chosen instead of a large selection of highly specific and often solely ecological-based indicators (as supported by Wascher, 2004). Overall, the PPUIGS Index includes the functional, compositional, and structural elements that, when combined, define the ecological system and provide a means to select a suite of indicators representative of the key characteristics of the system. Often it is easier to measure structural features that can convey information about the composition or functioning of the system than to measure composition or function (Lindenmayer et al., 2000). Importantly, these ecological-based characteristics were selected from established landscape ecology concepts that were specifically able to quantify the spatial condition and

biophysical structure of landscape fragmentation. Lastly, as a set of high-level indicators, they are more easily communicated to other disciplines and designers, planners, resource managers, and policy makers, thus improving their potential integration and usability. And, importantly, they can be measured and analysed over time, thereby improving the ability to monitor and assess both ecological and HWB conditions over time and landscape change.

Ecosystem integrity (i.e. ecosystem processes and functioning) occurs at multiple scales and resolutions and is considered inter-scalar. However, for this Index (Figure 4.4 and Table 4.4), the scale is considered that of the applied research methodology, a survey of local and regional GS visited (See Chapter 7) and as such is the site scale of City and Regional Parks and the other GS typologies per Table 3.3: Polycentric peri-urban green space and green structure typologies. There are no spatial units applied within the research to activate the testing of the index. A brief visual analysis of the GS found within polycentric peri-urban areas and the Case Study Areas not only facilitated the list of GS within Table 3.3, but provided the spatial metrics in which to apply the most appropriate indicators found within Figure 4.4.

These indicators, or characteristics, were validated through the literature review (See also Table 4.3 and Table 4.4). They are not solely ecological-based indicators nor sociological-based indicators, but distinctly chosen for their socio-ecological capacities to impact both ecological and human health simultaneously. As a hybridised set of socio-ecological characteristics and attributes, the PPUIGS Index triangulates spatial characteristics to both ecological integrity and human wellbeing as operationalized through behavioural interaction which places multiple indicators or PPUIGS Characteristics within the context of SELs and PULs. For example, Table 4.3 explicitly shows that literature specific to this research's PPUIGS Index (See Chapter 7). Table 4.4 lists the socio-ecological characteristics found within PPUIGS and the specific impacts to both ecological integrity and human wellbeing as supported through literature. It is these levels of measurement

and aspects that were operationalised in this research's applied methodology to assess their contribution to landscape services.

GREEN STRUCTURE CHARACTERISTIC	GREEN STRUCTURE ATTRIBUTE	SOURCES *Ecological Integrity* *Ecosystem Dynamics* *Landscape Fragmentation* Forman, 1995 Turner, 1989 Riitters et al., 1995 Antrop, 2000 Livingston et al., 2003 Harris, 1984 Forman and Godron, 1986 Alberti, 2005 de Groot, 1992
SIZE	1. AREA, 2. DENSITY 3. LARGEST	Llausàs and Nogué, 2012; Bru, 2009; Freebairn and King, 2003; Hammond et al., 1995; Rutledge, 2003; Turner et al. 1989; Benson & MacKenzie ,1995; Saura & Martinez-Millan, 2001; Vos et al., 2001; Haila, 2002; Wu & Qi, 2000;
SHAPE	1. REGULATION 2. ORIENTATION 3. COMPLEXITY and DIVERSITY 4. TYPOLOGY 5. VEGETATION STRUCTURE	Hargis et al. 1997; Huxel & Hastings 1999; Tscharntke et al., 2002; Whitford et al., 2001; Karr and Dudley, 1981; Barkmann and Windhorst, 2000; Lambin, 2001; Gunderson, 2000, Walker and Salt., 2006;
PROXIMITY	1. NEAREST NEIGHBOUR 2. ISOLATION and CONNECTIVITY 3. COHERENCE	Fahrig 2001; MacNally & Brown 2001; MacArthur & Wilson 1967; Pearson et al., 1996; Turner et al., 1989; Moilanen & Hanski, 2001; Tischendorf & Fahrig, 2000; Moilanen & Nieminen, 2002; Baguette et al., 2013;
EDGE	1. TOTAL EDGE 2. LONGEST EDGE 3. EDGE DENSITY	Saunders et al., 1991; Berry, 2001; Riitters et al., 1995; Hanski & Gilpin, 1991; Thomas et al., 1979; MacArthur and Wilson, 1967; Chen et al., 1992; Ranney et al., 1981; Lovejoy et al., 1986; Hopkins, 2013;

Table 4.3
Ecosystem Dynamics Literature specific to the PPUIGS Characteristics and Attributes Measured to Assess Ecological Integrity
(See Figure 4.4 - PPUIGS Characteristic Performance Index and Table 4.4)

This Index (Figure 4.4 - PPUIGS Characteristics Performance Measurement Index) supports the mixed-method approach of this research that correlates quantitative and qualitative data as well as specificity found within their levels (See Figure 4.4 and Table 4.4). All indicators are evenly weighted within the research's testing and analysis. This index was applied within the case studies of this research.

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS LEVELS (Levels of Measurement) Qualitative & *Quantitative* *(See Chapter 7 - 9)*	*ANTHROPOGENIC PPUIGS ASPECT (Human Wellbeing)* *SEE CHAPTER 4 and Section 4.6.1* *FIELD OF ACTION (Chapter 5)*	*BIOPHYSICAL PPUIGS ASPECT (Ecological Integrity)* *SEE CHAPTER 7 and Table A1.1* *FRAGMENTATION METRICS*	*SOCIO-ECOLOGICAL PPUIGS ASPECT (Common)* Impact patterns of design, planning and management of GS within the urbanisation process
SIZE	AREA	**Extensive** - green structure separates houses well, not see other houses within green structure or at green structure edges **Moderate** - green structure separates houses somewhat **Limited** - from green structure edge, one can see houses across from them	*Separation from Urban and Anthropocentric Elements* *Coherence* *Legibility*	*FUNCTIONAL CAPACITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY
SIZE	DENSITY	**High Density** - green structure is seen nearby **Moderate Density** - green structure is seen at a distance but not nearby **Low Density** - green structure is not seen at all	*Visible Density - visual access to green structure* *Opportunities and Access to Benefits* *Coherence* *Separation & Distinctness* *Mysteriousness*	*AGGREGATION* *SPATIAL HETEROGENEITY* *FUNCTIONAL CAPACITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY
SIZE	LARGEST	**Largest** - green structure is very large and is the largest (>75%) in the catchment area **Moderate** - green structure is normal sized when compared to others (in CA) (25%-75%) **Small** - green structure is very small and is the smallest (<25%) in the catchment area	*Spatial Context (per catchment area)* *Opportunities and Access to Benefits* *Hierarchy/Variety*	*MATRIX (Core-Hub)* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS LEVELS (Levels of Measurement) Qualitative & *Quantitative* *(See Chapter 7 - 9)*	*ANTHROPOGENIC PPUIGS ASPECT (Human Wellbeing)* *SEE CHAPTER 4 and Section 4.6.1* *FIELD OF ACTION (Chapter 5)*	*BIOPHYSICAL PPUIGS ASPECT (Ecological Integrity)* *SEE CHAPTER 7 and Table A1.1* *FRAGMENTATION METRICS*	*SOCIO-ECOLOGICAL PPUIGS ASPECT (Common)* Impact patterns of design, planning and management of GS within the urbanisation process
SHAPE	SHAPE - REGULATION	**Regular** - green structure is regularly shaped with mostly evenly-spaced and/or evenly-lengthed sides (rectangle, square, or mostly equilateral polygon - a circle or semi-circle is considered regular) **Moderate** - green structure is somewhat regularly shaped and, overall, most parts are regularly and evenly shaped with a few angled corners and possibly some linear and narrow portions. **Irregular** - green structure is not regularly shaped with many uniquely-angled corners and very few if any any similarly-spaced or similarly-lengthed sides **Linear** - green structure is considered a linear corridor such as a national bike path or river walkway	*Coherence* *Complexity - variety and diversity* *Sense of 'Naturalness'*	*COMPOSITION & CONFIGURATION* *SPATIAL HETEROGENEITY* *EDGE DYNAMICS* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS LEVELS (Levels of Measurement) Qualitative & *Quantitative* *(See Chapter 7 - 9)*	*ANTHROPOGENIC PPUIGS ASPECT (Human Wellbeing)* *SEE CHAPTER 4 and Section 4.6.1* *FIELD OF ACTION (Chapter 5)*	*BIOPHYSICAL PPUIGS ASPECT (Ecological Integrity)* *SEE CHAPTER 7 and Table A1.1* *FRAGMENTATION METRICS*	*SOCIO-ECOLOGICAL PPUIGS ASPECT (Common)* Impact patterns of design, planning and management of GS within the urbanisation process
SHAPE	COMPLEXITY and DIVERSITY	**Complex** - green structure is complex and diverse in shape. There are many sides (8+) and unique angles (e.g. 0-30deg, 110deg+) **Moderate** - green structure is neither complex nor simple in shape (4-8 sides). Somewhat regularly shaped. **Simple** - green structure is simple and uniform in shape (3-4 sides). It is very regularly shaped. **Linear** - the green structure is a linear corridor with a few larger areas (parking, amenities) along route.	*Coherence* *Complexity - variety and diversity* *Visual Stress* *Sense of 'Naturalness'*	*COMPOSITION & CONFIGURATION* *FRACTAL DIMENSIONS - RICHNESS* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY
SHAPE	TYPOLOGY	*If the green structure has a mixed spatial quality to it, the dominant portion or most used portion determines level* **Natural** - green structure feels wild and natural, sense of ruralness to it (e.g. Woodlands) **Moderate** - green structure feels neither natural or urban (e.g. Agricutlural and Grazing lands) **Urban** - green structure feels urban, not very natural or rural at all (e.g. Playing Fields, Civic Plaza, Monument)	*Coherence* *Complexity - variety and diversity* *Visual Stress Appropriateness* *Sense of 'Naturalness'* *Legibility*	*COMPOSITION & DIVERSITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS LEVELS (Levels of Measurement) Qualitative & *Quantitative* *(See Chapter 7 - 9)*	***ANTHROPOGENIC PPUIGS ASPECT (Human Wellbeing)*** ***SEE CHAPTER 4 and Section 4.6.1*** *FIELD OF ACTION (Chapter 5)*	***BIOPHYSICAL PPUIGS ASPECT (Ecological Integrity)*** ***SEE CHAPTER 7 and Table A1.1*** *FRAGMENTATION METRICS*	***SOCIO-ECOLOGICAL PPUIGS ASPECT (Common)*** Impact patterns of design, planning and management of GS within the urbanisation process
PROXIMITY	NEAREST NEIGHBOUR	**Connected** - green structure is physically connected to another at least 1 side (no street, wall, fence - path ok) **Nearby** - one can see another green structure (50m minimum width facing) from most parts of the green structure, but not physically connected. A street, rail or wall/ fence may separate the green structure. **Separated** - green structure is alone & separate, not physically or visually connected, cannot see another green structure from any parts of green structure	*Distance to and Amount of Access to Benefits* *Coherence* *Separation & Distinctness*	*AGGREGATION* *FUNCTIONAL CAPACITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY
PROXIMITY	ISOLATION and CONNECTIVITY	*When viewed without land ownership boundaries:* **Grouped** - considered 1 in a group of many green structures nearby **Moderate** - considered 1 in a group of few green structures nearby **Isolated** - only green structure, none in nearby group	*Distance to and Amount of Access to Benefits* *Legibility* *Coherence* *Separation & Distinctness*	*AGGREGATION* *COMPOSITION & CONFIGURATION* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY

PPUIGS CHARACTERISTIC	**PPUIGS ATTRIBUTE**	**PPUIGS LEVELS (Levels of Measurement) Qualitative & *Quantitative* *(See Chapter 7 - 9)***	***ANTHROPOGENIC PPUIGS ASPECT (Human Wellbeing)*** ***SEE CHAPTER 4 and Section 4.6.1*** *FIELD OF ACTION (Chapter 5)*	***BIOPHYSICAL PPUIGS ASPECT (Ecological Integrity)*** ***SEE CHAPTER 7 and Table A1.1*** *FRAGMENTATION METRICS*	***SOCIO-ECOLOGICAL PPUIGS ASPECT (Common)*** Impact patterns of design, planning and management of GS within the urbanisation process
EDGE	TOTAL EDGE (Quantity)	**Numerous** - green structure has many edges (8+) **Moderate** - green structure has a moderate amount of edges (4-8) **Few** - green structure has few edges (3-4)	*Impacts Accessibility & Visual Quality of Urban Space* *Mysteriousness* *Legibility* *Visual Stress* *Coherence* *Separation & Distinctness*	*EDGE* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY
EDGE	LONGEST EDGE (Length)	**Longest** - green structure has some or a very long edge, longest in area **Moderate** - green structure has normal edge sizes when compared to others **Least** - green structure has some or a very short edge, shortest in area	*Impacts Accessibility & Visual Quality of Urban Space* *Legibility* *Coherence*	*EDGE* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS LEVELS (Levels of Measurement) Qualitative & *Quantitative* *(See Chapter 7 - 9)*	***ANTHROPOGENIC PPUIGS ASPECT (Human Wellbeing)*** ***SEE CHAPTER 4 and Section 4.6.1*** *FIELD OF ACTION (Chapter 5)*	***BIOPHYSICAL PPUIGS ASPECT (Ecological Integrity)*** ***SEE CHAPTER 7 and Table A1.1*** *FRAGMENTATION METRICS*	***SOCIO-ECOLOGICAL PPUIGS ASPECT (Common)*** Impact patterns of design, planning and management of GS within the urbanisation process
ACCESSIBILITY	DISTANCE (CAR/BUS)	*For nearby neighbourhood(s):* **Close** - getting to the green structure requires a short vehicular ride (0-2 km) **Moderate** - getting to the green structure requires a moderate ride (2-5 km) **Far** - getting to the green structure requires a long vehicular ride (5+km)	*Opportunities and Access to Benefits*		LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY
ACCESSIBILITY	DISTANCE (LEVELS OF)	**Full Access** - entry to the green structure is possible without restriction. **Conditional Access** - a right of entry exists which is subject to or affected by one or more restrictions or conditions (e.g. hours, pass requirements, permitted use restrictions, etc) **Remote Access** - no physical right of access exists (e.g. gates, fence, wall), but the green structure provides a visual green resource whether viewed close or at a distance	*Opportunities and Access to Benefits* *Quality of Experience* *Legibility*		LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS LEVELS (Levels of Measurement) Qualitative & *Quantitative* *(See Chapter 7 - 9)*	*ANTHROPOGENIC PPUIGS ASPECT (Human Wellbeing)* ***SEE CHAPTER 4 and Section 4.6.1*** *FIELD OF ACTION (Chapter 5)*	*BIOPHYSICAL PPUIGS ASPECT (Ecological Integrity)* ***SEE CHAPTER 7 and Table A1.1*** *FRAGMENTATION METRICS*	*SOCIO-ECOLOGICAL PPUIGS ASPECT (Common)* Impact patterns of design, planning and management of GS within the urbanisation process
GREENESS	VEGETATION COMPOSITION	**Deciduous** - green structure with predominately deciduous vegetation types **Evergreen** - green structure with predominately evergreen vegetation types **Mixed** - green structure with a fair mixture of different (evergreen and deciduous) vegetation types green structure **Play fields or Grass** - green structure which is a playing field or a grass area (including grazing and agricultural or farming fields)	*Legibility* *Complexity*	*ECOLOGICAL INTEGRITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS LEVELS (Levels of Measurement) Qualitative & *Quantitative* *(See Chapter 7 - 9)*	*ANTHROPOGENIC PPUIGS ASPECT (Human Wellbeing)* *SEE CHAPTER 4 and Section 4.6.1* *FIELD OF ACTION (Chapter 5)*	*BIOPHYSICAL PPUIGS ASPECT (Ecological Integrity)* *SEE CHAPTER 7 and Table A1.1* *FRAGMENTATION METRICS*	*SOCIO-ECOLOGICAL PPUIGS ASPECT (Common)* Impact patterns of design, planning and management of GS within the urbanisation process
EDGE	EDGE DENSITY (Vegetation or Structures)	*Edge Condition can be vegetation (trees, shrubs) and/or built structures (fence, wall, houses, etc)* **Dense** - dense edges, not very visible into green structure, blocks views into green structure **Moderate** - some edge areas offer visibility into green structure **Transparent** - very open edges, easily visible into green structure from outside-in or inside-out	*Relationship to Surroundings including Safety, Visibility, Legibility* *Opportunities and Access to Benefits* *Attractiveness* *Coherence* *Separation & Distinctness* *Mysteriousness*	*EDGE* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY
ACCESSIBILITY	DISTANCE (WALK)	*For nearby neighbourhood(s):* **Close** - getting to the green structure requires a short walk (0-5 min or 0-400 m) **Moderate** - getting to the green structure requires a long walk (5-10 min or 400 - 800m) or bike **Far** - getting to the green structureGS requires a car or bus (over 10 minutes, over 800m)	*Opportunities and Access to Benefits*	*EDGE* *Ecological Patch Dynamics*	

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS LEVELS (Levels of Measurement) Qualitative & *Quantitative* *(See Chapter 7 - 9)*	*ANTHROPOGENIC PPUIGS ASPECT (Human Wellbeing)* *SEE CHAPTER 4 and Section 4.6.1* *FIELD OF ACTION (Chapter 5)*	*BIOPHYSICAL PPUIGS ASPECT (Ecological Integrity)* *SEE CHAPTER 7 and Table A1.1* *FRAGMENTATION METRICS*	*SOCIO-ECOLOGICAL PPUIGS ASPECT (Common)* Impact patterns of design, planning and management of GS within the urbanisation process
GREENESS	VEGETATION COMPOSITION - SETTING *(May have 1 or more of the following:)*	*Regardless of facilities or amenities including paths, lights, bins, benches, centres, toilets:* **Natural** - green structure is very natural and has no informal recreation opportunities (beyond trail walking, wildlife viewing, etc), a wide variety of vegetation types and/or types of habitats and with predominately natural or naturalistic vegetation. Green structure lacks a formal composition and may have a 'wild' feeling to it. **Semi-Natural** - green structure still has a natural feeling to it and a few informal recreation opportunities (beyond trail walking, wildlife viewing, etc) with a variety of vegetation types or limited types of habitats and with some natural or naturalistic vegetation or areas. Agricultural Fields and Grazing Lands are often considered of this Setting. **Semi-Urban** - green structure has a few informal and at least one formal recreation area. There is a good mixture of both formal and informal plantings and habitat or vegetation types. Some large, manicured grassed areas.	*Type of Interaction and type of Benefit/ Affordance Received* *Social Interaction* *Biodiversity* *Legibility* *Attractiveness* *Hiearchy* *Appropriateness*	*ECOLOGICAL INTEGRITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY

PPUIGS CHARACTERISTIC	**PPUIGS ATTRIBUTE**	**PPUIGS LEVELS (Levels of Measurement) Qualitative & *Quantitative* *(See Chapter 7 - 9)***	***ANTHROPOGENIC PPUIGS ASPECT (Human Wellbeing)*** ***SEE CHAPTER 4 and Section 4.6.1*** *FIELD OF ACTION (Chapter 5)*	***BIOPHYSICAL PPUIGS ASPECT (Ecological Integrity)*** ***SEE CHAPTER 7 and Table A1.1*** *FRAGMENTATION METRICS*	***SOCIO-ECOLOGICAL PPUIGS ASPECT (Common)*** Impact patterns of design, planning and management of GS within the urbanisation process
GREENESS	VEGETATION STRUCTURE - HORIZONTAL *(not dependent upon vegetative composition)*	*Deciduous and/or Coniferous Vegetation Types, Vertical is under 4' height:* **Diverse and Random** - green structure with many different horizontal vegetation types whose diversity is visually dominant. Distribution is many and informal/wild. **Clustered** - a few or many different horizontal vegetation types, but not present in all areas of green structure. Horizontal vegetation is distributed only in clumps or massed planting areas. **Uniform** - green structure with hardly any or different horizontal vegetation types (e.g. play fields, mown grass parks). Little horizontal vegetation distribution within GS.	*Complexity - variety and diversity* *Visual Stress*	*COMPOSITION & CONFIGURATION* *HETEROGENEITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS LEVELS (Levels of Measurement) Qualitative & *Quantitative* *(See Chapter 7 - 9)*	***ANTHROPOGENIC PPUIGS ASPECT (Human Wellbeing)*** ***SEE CHAPTER 4 and Section 4.6.1*** *FIELD OF ACTION (Chapter 5)*	***BIOPHYSICAL PPUIGS ASPECT (Ecological Integrity)*** ***SEE CHAPTER 7 and Table A1.1*** *FRAGMENTATION METRICS*	***SOCIO-ECOLOGICAL PPUIGS ASPECT (Common)*** Impact patterns of design, planning and management of GS within the urbanisation process
GREENESS	VEGETATION STRUCTURE - VERTICAL *(not dependent upon vegetative composition)*	*Deciduous and/or Coniferous Vegetation Types, Vertical is over 4' height:* **Diverse and Random** - green structure with many different vertical vegetation types whose diversity is visually dominant. Distribution is many and informal/wild. **Clustered** - a few or many different vertical vegetation types, but not present in all areas of green structure. Vertical vegetation is distributed only in clumps or massed areas. **Uniform** - green structure with hardly any or different vertical vegetation types (e.g. allees, walkways). Little vertical vegetation distribution within green structure (many open spaces). None visually dominant.	*Complexity - variety and diversity* *Visual Stress*	*COMPOSITION & CONFIGURATION* *HETEROGENEITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY
GREENESS	VEGETATION STRUCTURE - DENSITY *(not dependent upon vegetative composition)*	*Deciduous, Mixed and Coniferous Vegetation, Horizontal and Vertical, Considered Spatially:* **Dense** - within green structure, many dense or clustered plantings, crowded and tightly-packed. **Moderate** - within green structure, both dense and sparse areas **Open** - within green structure, sparse plantings, few plantings, spacious (mostly grass areas, play fields).	*Visual Quality, Affordance* *Coherence* *Social Interaction* *Complexity - variety and diversity* *Legibility Mysteriousness*	*COMPOSITION & CONFIGURATION* *HETEROGENEITY* *AGGREGATION* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS LEVELS (Levels of Measurement) Qualitative & *Quantitative* *(See Chapter 7 - 9)*	*ANTHROPOGENIC PPUIGS ASPECT (Human Wellbeing)* *SEE CHAPTER 4 and Section 4.6.1* *FIELD OF ACTION (Chapter 5)*	*BIOPHYSICAL PPUIGS ASPECT (Ecological Integrity)* *SEE CHAPTER 7 and Table A1.1* *FRAGMENTATION METRICS*	*SOCIO-ECOLOGICAL PPUIGS ASPECT (Common)* Impact patterns of design, planning and management of GS within the urbanisation process
GREENESS	VEGETATION STRUCTURE - VISIBILITY	**Extensive** - within green structure, many (3+) long and expansive views, within green structure and/or out from green structure **Moderate** - within green structure, a few (1-3) extensive views, some areas with limited visibility **Limited** - within green structure, no long or expansive views either within green structure or out from green structure, limited visibility	*Relationship to Surroundings including Safety, Visibility* *Opportunities and Access to Benefits* *Coherence* *Legibility* *Mysteriousness*	*ECOLOGICAL INTEGRITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY
GREENESS	VEGETATION STRUCTURE - SLOPE	**Steep** - within green structure, many steep and non walkable slopes. **Moderate** - within green structure, a few moderate and challenging slopes. **Flat** - within green structure, generally flat and easily manoeuvrable	*Relationship to Surroundings including Safety, Visibility* *Opportunities and Access to Benefits* *Coherence* *Legibility* *Visual Stress*	*ECOLOGICAL INTEGRITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS LEVELS (Levels of Measurement) Qualitative & *Quantitative* *(See Chapter 7 - 9)*	*ANTHROPOGENIC PPUIGS ASPECT (Human Wellbeing)* *SEE CHAPTER 4 and Section 4.6.1* *FIELD OF ACTION (Chapter 5)*	*BIOPHYSICAL PPUIGS ASPECT (Ecological Integrity)* *SEE CHAPTER 7 and Table A1.1* *FRAGMENTATION METRICS*	*SOCIO-ECOLOGICAL PPUIGS ASPECT (Common)* Impact patterns of design, planning and management of GS within the urbanisation process
GREENESS	PROXIMITY TO HEAVY TRAFFIC ROAD	**Close** - the green structure is directly adjacent to heavy traffic road (M, A or 4-Lane Road) **Moderate** - one can see or hear traffic road within green structure (M, A, B or 4-Lane Road) **Far** - no heavy traffic road in in visual or aural proximity of green structure	*Attractiveness* *Legibility*	*ECOLOGICAL INTEGRITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY
MAINTENANCE AND MANAGEMENT	CLEANLINESS	**Clean** - green structure is well maintained or managed. Pavement is not cracked, vegetation is trimmed, grass is mowed often. Not many exposed dirt areas, no dog fouling. No graffiti or rubbish seen outside bins. Benches are clean and sturdy. 'Tidy' green structure. **Moderate** - green structure adequately maintained, some dirty areas. **Dirty** - green structure not well maintained or managed, messy. Pavement cracking and limited grass and vegetation maintenance. If present, buildings and structures/amenities not well maintained or clean. Rubbish and graffiti may be seen. Not a 'Tidy' green structure.	*Attractiveness* *Legibility* *Visual Stress*	*ECOLOGICAL INTEGRITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS LEVELS (Levels of Measurement) Qualitative & *Quantitative* *(See Chapter 7 - 9)*	*ANTHROPOGENIC PPUIGS ASPECT (Human Wellbeing)* *SEE CHAPTER 4 and Section 4.6.1* *FIELD OF ACTION (Chapter 5)*	*BIOPHYSICAL PPUIGS ASPECT (Ecological Integrity)* *SEE CHAPTER 7 and Table A1.1* *FRAGMENTATION METRICS*	*SOCIO-ECOLOGICAL PPUIGS ASPECT (Common)* Impact patterns of design, planning and management of GS within the urbanisation process
MAINTENANCE AND MANAGEMENT	FACILITIES (AMENITIES)	**Abundant** - green structure has many facilities and/or user amenities (e.g. benches, tables, paved areas, toilets, drinking fountain, signage, cafe, bins, etc) throughout. **Adequate** - green structure has a good amount of facilities and/or user amenities **Inadequate** - green structure has few facilities and/or user amenities	*Evaluation to achieve benefits/affordances* *Social Interaction* *Attractiveness* *Hierarchy* *Legibility/Variety*	*ECOLOGICAL INTEGRITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY
MAINTENANCE AND MANAGEMENT	FACILITIES (PATHS)	*NOT quality of pavement or paths, not maintenance level - only provision of paths:* **Paved** - nearly all paths are paved (non-porous) **Mixed** - some non-paved trails and walking tracks & some paved paths and walking/ cycling areas **Unpaved** - no paved paths or trails	*Evaluation to achieve benefits/affordances* *Attractiveness* *Legibility*	*ECOLOGICAL INTEGRITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS LEVELS (Levels of Measurement) Qualitative & Quantitative (See Chapter 7 - 9)	ANTHROPOGENIC PPUIGS ASPECT (Human Wellbeing) SEE CHAPTER 4 and Section 4.6.1 FIELD OF ACTION (Chapter 5)	BIOPHYSICAL PPUIGS ASPECT (Ecological Integrity) SEE CHAPTER 7 and Table A1.1 FRAGMENTATION METRICS	SOCIO-ECOLOGICAL PPUIGS ASPECT (Common) Impact patterns of design, planning and management of GS within the urbanisation process
MAINTENANCE AND MANAGEMENT	FACILITIES (SOCIABILITY)	**High** - the green structure has exposed spaces with many places for social interaction, both formal & informal. There is a designated dog space. Many benches and seating areas, possibility of a playground or communal area. green structure can accommodate large groups. **Mixed** - the green structure has both exposed and communal spaces and more solitary and alone spaces. Not many communal areas but still some spaces for large groups. **Low** - the green structure has mostly solitary and isolated spaces. Not many benches or tables.	*Evaluation to achieve benefits/affordances* *Social Interaction* *Attractiveness* *Hierarchy* *Legibility/Variety*	*ECOLOGICAL INTEGRITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY
SAFETY AND SECURITY	SAFETY and SECURITY	*Presence of lighting, locked gates, open edges, visibility/eyes-on, management:* **Safe** - many lights and open edges, visibility within and throughout is high. Somewhat Safe - some lights and/or some edges are open. Visibility is acceptable at some places. **Unsafe** - minimal or no lights, enclosed and dark edges, low visibility. Many dark areas.	*Evaluation to achieve benefits/affordances* *Attractiveness* *Hierarchy* *Legibility*	*ECOLOGICAL INTEGRITY* *Ecological Patch Dynamics*	LANDSCAPE SERVICES URBAN PATTERN BIODIVERSITY

Table 4.4
PPUIGS Integrated Characteristics, Attributes and Measurement Levels

This table lists the socio-ecological characteristics found within PPUIGS and the specific impacts to both ecological integrity and human wellbeing as supported through literature. It is these levels of measurement and aspects which were operationalised in this research's applied methodology to assess landscape services.

It should be noted that these indices do not serve to classify or define GS, or present a list of GS typologies, nor to deconstruct their aesthetic constructs, only describe their eco-spatial characteristics. This list of PPUIGS characteristics is heterarchical and serves to identify and describe the variability between GS found within polycentric, fragmented peri-urban regions of Europe.

4.7 Summary of the HWB Benefits of Green Space

This list of PPUIGS characteristics and attributes represents a core grouping of high-level indicators that are easier to comprehend in many disciplines. Furthermore, this index collectively represents the PPUIGS' eco-spatial characteristics and the direct and indirect benefits or landscape services that can be explicitly measured and evaluated. Lastly, the index's framework improves the understanding of the drivers and consequences, or impacts, of landscape fragmentation (Jenerette and Wu, 2001) found withn PPUIGS of PULs.

As discussed, the landscape has multiple dimensions; so too do its GS, facilitating diverse scenarios for interaction. Evidence from an assortment of empirical and qualitative studies show that exposure to GS benefits HWB. Place-based research on HWB has always proved difficult to correlate; understanding where and for whom GS and other spatio-temporal environments provide which specific benefit is complex. The work of Ralz (2003), Gobster (2004), Bedimo-Rung et al., (2005), Giles-Corti et al. (2005), and the REAT - Residential Environment Assessment Tool as designed by Dunstan et al. (2005), and Gehl (2010) assessed subjective measures within GS characteristics affecting HWB. Although most of these studies are inherently associated to GS preference, they hold significant meanings specific to spatial planning and the physical structure of GS (Ulrich, 1981; Kaplan, 1995, 1998). Important characteristics and concepts studied within these works include cleanliness, naturalness, safety, access, coherence and legibility, complexity and mysteriousness, appropriateness of development, separation, aesthetics, and facilities or features such as benches, seats and restrooms.

Aesthetics and scenic value are both very difficult qualities to measure objectively and thus were not utilised in this research[18], For instance, scenery, attractiveness, visual appeal of features, vegetation type, density, colours, scents and sounds are all components of aesthetic discourse. Humpel et al. (2002) reported the 'aesthetic attributes' of the environment as one of the factors that influences the use of GS for physical activity such as cycling (Titze et al., 2007) and walking (Ball et al., 2001).

To date, much of the literature within the context of subjective HWB benefits and GS has been confined to the more naturalistic characteristics of GS (e.g. their sense of wildness or naturalness) or UGS (e.g. urban vegetation and greening). But in PPUIGS, there is a mixture of both characteristics, resulting in hybridised green spaces or modified green structures, where both biophysical and anthropic characteristics exist simultaneously. For example, in the PUL, the likelihood of impromptu or informal interaction with GS is more common than within dense urban areas.

Perhaps not surprising, the GS wellbeing benefits are interrelated, with each supporting one another and interacting to facilitate benefits, this is referred to as the *synergestic effect* of interacting with GS. For example, physical health can be increased through strong social wellbeing (Uchino, 2006). Psychological wellbeing is shown to be more positive with strong social networks (Umberson and Montez, 2010). Physical and mental wellbeing are both components of positive GS interaction where access, physicality and mental restoration operate together. Jacobs (1961) demonstrated the correlations between human health and social interaction. Empirically, economists have also been able to show a strong correlation between citizens and economic growth. Fan, Das and Chen (2011) concluded that parks *"directly promote physical activity, and indirectly mitigate stress via the spaces' positive impact on social support"* (p. 1209). Similarly, walking, cycling, and other outdoor sports or activities have been shown to improve

[18] Aesthetics are strongly related to personal perception and preference, and it was determined that these aspects of the human-nature relationship could not be measured accurately within this research's goals.

both physical and psychological wellbeing (Davis, 1999; Countryside Agency, 2000) and spiritual health (Hickmann et al., 1999).

Overall, a significant body of literature provides empirical documentation of the benefits to HWB of direct and indirect interaction with GS.[19] Although there are inevitably considerable variables in all these studies that may affect their results, the evidence is overwhelming; humans are afforded positive wellbeing benefits through interaction with green space and green structures in the landscape.

[19] For an in-depth review of the various human wellbeing benefits associated with green spaces, refer to Health, Well-Being and Open Space - Literature Review as compiled by the OpenSpace Research Centre at the University of Edinburgh (Morris, N., Health, well-being and open space: literature review. Edinburgh: OPENspace; 2003). This research did not compile an exhaustive evidence base as it would duplicate existing literature. This particular publication provides specific references to the many benefits specific to Human Wellbeing Dimension Categories as noted in Section 4.2.1.

Chapter 5 - Affordance Theory

5.1 Affordance Theory – A Lens for Studying Human Wellbeing and Green Space Interaction

It is this research's interpretation of landscape services (i.e. comprehensive ecosystem services) within the context of the PolyPULs, PPUIGS, and HWB that allows examination into the human-nature relationship through the interactionist perspective found within Affordance Theory. Evolving from transactional person-environmental research, the theoretical basis for this research's approach lies within the interdisciplinary fields of cognitive science, environmental psychology (See Section 5.3) and the Theory of Affordance (Gibson, 1979).

The theory of affordance, originating in the field of perceptual psychology, is finding increasing popularity in a variety of disciplines, particularly in the area of design. Scholarly research on its value for spatial planning and landscape architecture is minimal, however, with articles tending to place landscape and affordance together (e.g. Silva et al., 2013; Rietveld, 2008), and to take the perspective of perceptual psychology (e.g. Chemero, 2009; Dreyfus, 2008). This implies that the application of affordance theory in landscape architecture from the perspective of landscape architects and spatial planning is not yet fully explored.

This Chapter introduces the theory of affordance then relates the fundamental principles of affordance to various human-environment theories in order to understand this relationship better within the research's context of HWB and PPUIGS. This relationship is theorised, analysed and measured through a modified affordance model (See Figure 5.1) and is operationalised through the use of a public participation geographic information system (PPGIS) – SoftGIS - discussed in Chapter 7 which activates the PPUIGS - HWB transactional relationship through data collection.

Placing this research's concept of affordances within a diagram allows for a more descriptive understanding of the reciprocal relationship between individual and landscape in explaining what activities are possible or take place in specified GS and the many factors influencing such action.

This model's individual-environment framework has been widely used to structure and understand the biophysical environmental factors influencing human behaviour (e.g. Raymore, 2002; Owen et al., 2004; Sallis et al., 2006). The human-nature relationship requires a complete understanding of the 'system' or 'environment' in which a person lives (Bronfenbrenner, 1979). For this research, the environmental context is the PPUIGS present in PULs.

Specifically, this research operationalised a hetarchical group of eco-spatial PPUIGS indicators that, together, served as a conceptual proxy for the positive interactions specific to fragmented landscapes and GS within PolyPURs that contribute to both the ecological and socio-cultural aspects of functional landscape dynamics (See Chapter 4 and Figure 4.2 Summary of HWB Benefits Received through Green Space Interaction and Figure 4.3 - PPUIGS Characteristics Performance Index).

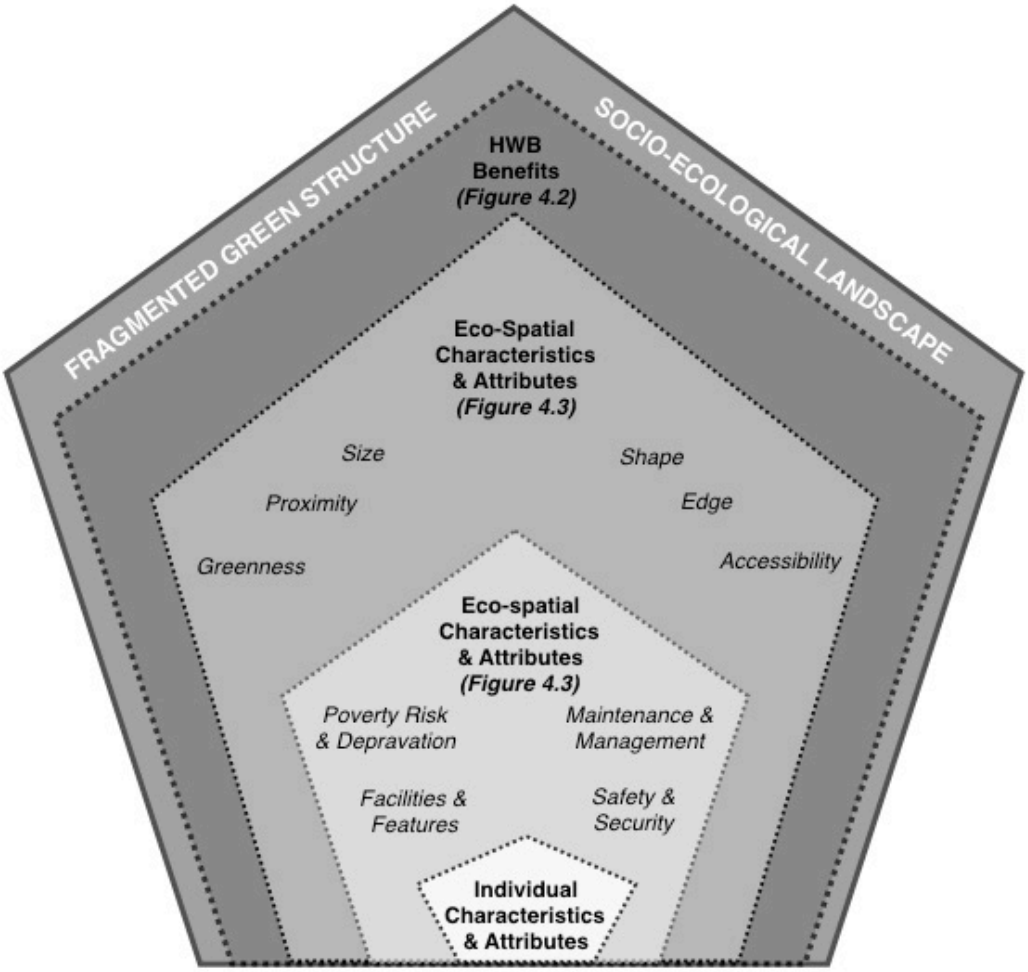


Figure 5.1
Afffordance Model

This model illustrates the socio-ecological factors or indicators found within the human-nature relationship of human interaction with PPUIGS. The factors listed are those found within Figure 4.2 Summary of HWB Benefits Received through Green Space Interaction and Figure 4.3 - PPUIGS Characteristics Performance Index.

This model was modified from *Schipperjin (2010), which was inspired by Giles-Corti (2005) and the factors developed from various Person-Environment or SocioEcological Models and Theories.*

The PPUIGS Characteristics Performance Measurement Index (Figure 4.4) provided a set of measurable physical attributes. By understanding the context of the PPUIGS within these transitional landscapes, PolyPURs can better analyse and manage spatial planning and design strategies to provide benefits to both humans and nature or landscape services (See Figure 5.2).

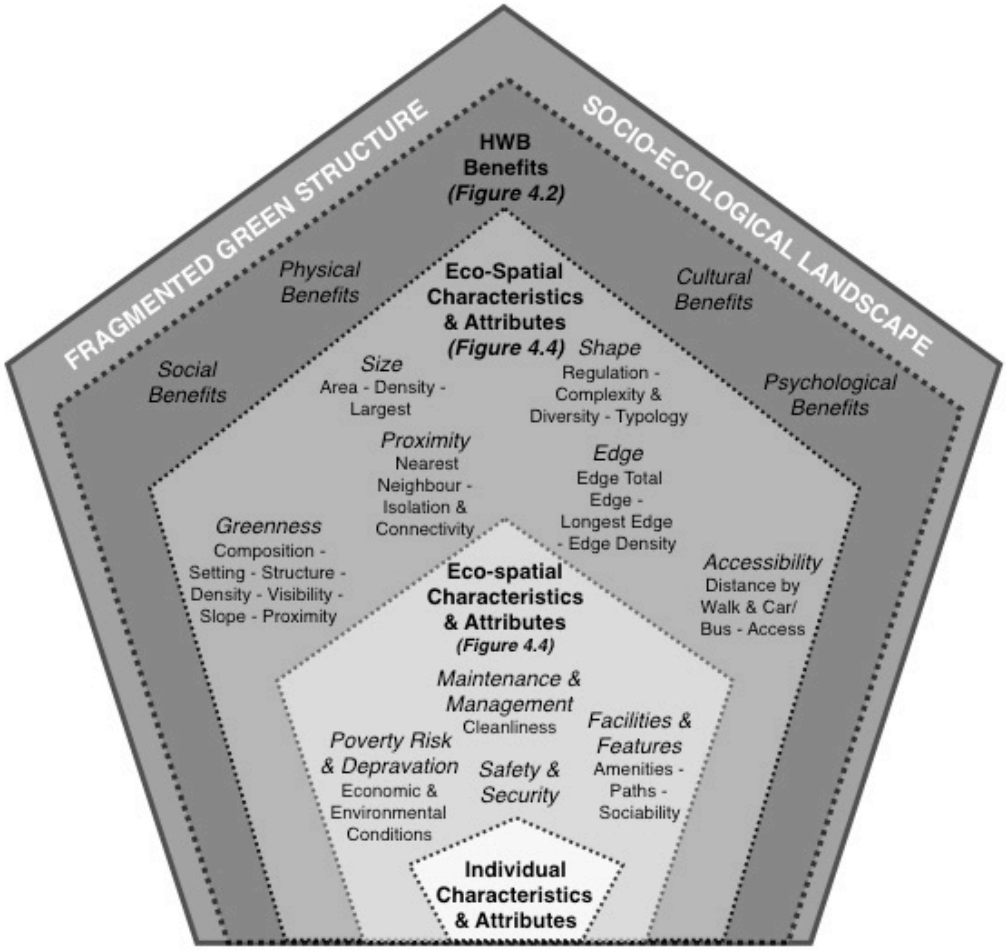


Figure 5.2
Comprehensive Affordance Model

This model builds opon the Affordance Model of Figure 5.2 to illustrate the specific measurable attributes found within PPUIGS The factors listed are those found within Figure 4.2 - Summary of HWB Benefits Received through Green Space Interaction and Figure 4.4 - PPUIGS Characteristics Performance Measurement Index.

5.1.1 Affordance Theory – Concept and Semantics

This thesis utilises an applied methodology for an interdisciplinary PhD dissertation. Many of the terms and concepts within this section are new to the fields of landscape architecture and spatial planning, and a common understanding of many of these terms is incomplete. This thesis, therefore, intends to develop more fully some key concepts as a contribution to theory and knowledge. Within this research's theoretical discussions, the terms documented for the concepts discussed are not inherently important (e.g. perceived affordance, functional

affordance), but the semantics or explanations behind the terminology and relationship expressed between them is worthy of attention.

In particular, the concept of affordance requires clarity. Placing the term affordance within uncertain and unclear associations is faulty; shared meanings and representations are requisite to express semantics in the design disciplines, social sciences, academia, and the wider world.

5.2 Theory of Affordance

This research's experimental design and applied methodology are based on the Theory of Affordance (Gibson, 1979). James J. Gibson and his wife, Eleanor, first proposed the concept of 'affordances' to describe how humans interact with their environment. Gibson stated that an affordance is a *"functionally significant property of the physical environment"* (ibid). It is a perception by the observer of the possibility for an action or behaviour that the observer intends or is capable of doing (Barker, 1968; Reed, 1996).

Simply stated, affordance refers to a possibility for a desired action. For example, if there is a steep and rugged dirt path through a forest it offers the affordance of walking or cycling, but only if the individual perceives this through their ability or functional skill-level to walk or cycle. Affordance, then, is relational and dependent on both the characteristics of the environment and the characteristics of the individual (Greeno, 1994; Jones 2003).

Affordances also arise from the individual's intentions and the opportunities within the landscape. For example, an individual may have a desire or intention to relax in nature and listen to wildlife. If there are no such landscapes available to the individual to fulfil this desired action, however, the affordance is thus unmet to that individual, although the landscape characteristics and individual characteristics remain constant. Affordances, in this regard, may be considered a matter of the fit between the individual's (or group's) characteristics, the individual's desired activity, and the landscape's, or PPUIG's, characteristics (Lynch, 1981: ch. 9).

Stated succinctly, affordances are properties of the environment, although dependent on an individual's perception and intention. Recent discussions within the social sciences and landscape architecture disciplines refer to affordances as an

‘opportunity for action’ (e.g. Heft, 2001; Jones, 2003). Importantly, however, an affordance is not achieved until there is an interaction of the individual with the environment. Affordance, therefore, is both a physical characteristic of the landscape and a perceived characteristic of the individual; an affordance is met when the individual’s characteristics and activity is supported or intention fulfilled by the landscape’s characteristics.

Discussion persists over where exactly affordance exists within the human-environment relationship. Gibson is reported to have stated that an affordance does not change with the changing needs or desires of the individual and that it is the individual who perceives that the affordance exists (Clark and Uzzell, 2002). This perspective presumes that the affordance is based within the landscape, or object, not the individual. Within this deterministic perspective, affordances can exist independent of the individual and their desired interaction or personal characteristics such as skill-level. The literature contests such positions (Greeno, 1994; Rietveld and Kiverstein, 2014). Chemero states that affordances are not properties of the environment or individual/observer, but of whole systems and contextually dependent (Chemero, 2003). Heft appears to agree (2003), illustrating this by considering the affordance a chair provides for sitting in two differing situations. A chair in their own living room affords sitting on, but a similar chair in a museum with a cordon around it would not afford sitting due to the socio-cultural meaning or intent of the context leading to the realisation that the observer is not supposed to sit on this particular chair. Overall, affordances are adaptive, dynamic, spatio-temporal and contextual (Norman, 2002; Heft, 2003; Menatti and Casado da Rocha, 2016).

5.2.1 Theoretical Approach – Capability Theory vs. Affordance Theory

The research considered two theoretical frameworks within the human-nature relationship specific to achieving HWB: Affordance Theory (AT) and Capability Theory (CT). CT pioneered by Amartya Sen (1983) and Martha Nussbaum (1992)

emphasise functional capabilities within the individual[22]; capabilities are an individual's freedoms or opportunities to achieve functionings, specifically HWB. For example, jogging is a functioning, the tangible opportunity to jog is the corresponding capability.

Conceptually, CT is an effective framework to assess interpersonal HWB (Ingrid, 2011) and is well situated to human development and ethnographic studies within welfare economics (see Robeyns, 2006). Theoretically, CT removes individual subjective factors - focussing on the determined action (i.e. freedom of choice) for a desired outcome. This is questioned - there is a significant lack or CT's operationalised studies and empirical results. Current CT studies utilise such human values like health, wealth, opportunity, freedom, democracy, knowledge, privacy, security, and self-fulfilment - all extremely difficult concepts to measure accurately and consistently as well as effectively analyse.

Both theories provide valid approaches to analyse HWB within the human-nature relationship. Similarities include:

1. Both theories allow for various individual factors as well as environmental factors to impact behaviours/actions in achieving HWB;
2. Both take a transactional and experiential perspective to achieving HWB; both require an active relationship;
3. Both theories use equivalent concepts yet different terms (AT = usability, CT = capability).

However, AT includes the basic, operational tenets of CT within its aspects of perceived and functional affordance (See Figure 5.3). Adding to the example prior, jogging is a functioning, the real-world opportunity to jog is the corresponding capability, and a safe, flat, surfaced pathway is the physical landscape required to meet that capability - its affordance. This capability – or capacity - is discussed

[22] For a full discussion and review of human (or group) capabilities including basic capabilities, internal capabilities, and combined capabilities see the evolving works of Nussbaum (1992, 1993, 1995, 2000).

within the model's aspects of affordance.

In the context of this research, AT provides a more integrated framework to analyse the individual-environment relationship within the socio-ecological landscape such as PULs; whereby CT operates from a more individualistic perspective and less on the functional relationship.

5.2.2 Affordance and Transactionalism

Affordances are not passive, they exist through action and dynamic relation (Menatti and Casado da Rocha, 2016). Hartig (1993) refers to these mutually dependent landscapes of affordance as 'transactional' (Ittelson, 1996). Altman and Rogoff (1987) state that affordances are only evident within interacting systems. Within this transactionalist perspective, the complex dynamic relationship between individuals and the environment is mutual.

The philosophical theory for transactionalism was founded by William James and John Dewey, and others (see Heft, 2001). This paradigm is contrasted with the 'interactional' approach where the interaction between person and environment is deconstructed into discrete elements and analysed through the interaction between psychological variables and natural features, modified by distinct personal, situational and temporal factors. A 'transactional' approach, by contrast, studies person-environment systems, formed and defined by the simultaneous and combined action of their aspects (Altman and Rogoff, 1987). It should be noted, however, that both approaches consider that "*person and environment are mutually defining*" (ibid, p. 19)

Supporting Chemero's view (2003), this research conceives affordances as transactional and relational – neither residing in the individual nor the environment; they are an emergent property that resides specific to that landscape and that individual at that time.[23]

Affordance theory is utilised in many objectivist perspectives on the human-nature relationship. Affordances, viewed as properties, but still transactional, often

[23] For a discussion of emergent interaction affordances, see Worgan and Moore, 2010.

focus on elements or objects within the landscape. For example, a bench affords sitting in a much more accommodating way than a garbage can. But a bench offers more affordances than just sitting – for a human, it can be used to stretch legs over the back rest, it can provide a napping or sleeping surface, it even provides shelter from rain or snow to small animals and insects. This research, therefore, moves beyond objectivist perspectives within its analysis of landscape of affordances in understanding the specific mechanisms for achieving HWB thorugh GS interaction

Humans are constantly presented with a landscape full of diverse affordances. Culture, language, history, science, design and other disciplines coalesce to create these landscapes of affordances (Francovich, 2010). Before we engage in action, however, something occurs – cognition, perception and preference. Literature is abundant with these topics and this research's applied experimental design through AT does not require detailed review, however a succinct discussion is included in the next section and discussed as required to clarify and support literature.

5.3 Landscape of Affordances - Cognition, Perception, Preference and Action

Humans are constantly presented with a landscape full of diverse affordances. Culture, language, history, science, design and other disciplines coalesce to create these landscapes of affordances (Francovich, 2010). Before we engage in action, however, something occurs – cognition, perception and preference. Literature is abundant with these topics and will be only summarised herein.

Theory within landscape cognition and perception studies often focus on environmental aesthetics. Termed 'scientific cognitivism' (Carlson and Lintott, 2008), the aesthetic qualities of the landscape are interpreted through specific scientific, often abstract, cognitive constructs. Berleant states that aesthetics "*is shaped by cognitive, cultural, and personal influences*" (Berleant 2007: 316). Yet this aesthetic perspective removes the individual from the landscape, rendering participation or action separate. Heft and Nasar (2000) refer to this as "*the spectator stance*" in the human-nature relationship.

Affordance theory is both subjective and objective (Berleant, 2007) whereas aesthetic theory is wholly subjective, and often separates the person from the object/landscape (Pasons, 2002; Carlson 2006). Aesthetics was removed from this study's methodology for assessing human wellbeing, primarily because it could not be measured empirically and accurately within scientific approaches.

Perception, cognition, and evaluation or preference are highly interrelated processes (Kaplan 1987). Both perception - the immediate apprehension of the environment - and cognition - the way information is organised, stored and recalled – are influenced by internal evaluation. Goldstone and Barsolou discuss this complex relationship when noting that cognitive information influences perceptual processes, but, at the same time, cognitive processes require perceptual information (1998). Yet the point at which visual perception evolves to cognition is a matter of debate (e.g. Rosch et al., 1976; Grush, 2004; Raftopoulos and Mueller, 2006).

Further support for affordance theory within GS interaction and HWB can be found in Farina and Belgrano's Eco-Field Hypothesis (2005) where the physical and spatial arrangement of a landscape (i.e. eco-field or habitat) has a specific value to the individual (i.e. organism) but only when there is direct engagement or the activity (i.e. living function) is activated. Their model provides another contribution that connects concepts of cognition, perception, and value not only to human action but also the spatial landscape. The eco-field is a function-specific perceived 'piece of land' with a specific spatial configuration. This concept is similar to that of a habitat or an operational space (Farina and Belgrano, 2005) found within spatial-ecology. For example, a red fox (*Vulpes vulpes***)** has certain functions it performs in the landscape – food gathering, mating, migration, territorialisation, sleeping. This requires an operational space or habitat with specific biophysical, spatial characteristics to achieve the best performance of the selected function.

5.3.1 Landscape Perception and Affordance

The concept of affordance, therefore, concerns the relationship of the person to the environment; this relationship is dynamic and is based on perception and action (Gibson, 1966, 1979; Barker, 1968). The field of ecological psychology

(Good, 2006; Heft, 2001; Reed, 1996) places perception/environment relations within the theoretical framework of affordance.

Landscape perception is considered to be a function of the interaction between people and the environment. Zube et al. (1982) proposed three components for landscape perception: human, landscape and interaction. The human component includes past experience, knowledge, expectations and the socio-cultural context of individuals and groups. The landscape component, meanwhile, includes both individual elements and landscape as a separate entity. This interaction results in outcomes that in turn affect both the human and the landscape components.

According to Gibson (1979), the purpose of perception is to perceive affordances. More comprehensively, however, landscape perception may be defined as how an individual makes sense of the landscape and what it may offer (Ward Thompson, 2013). In this regard, landscape perception may be most similar to perceived affordance in this study's model (See Figure 5.3). Literature supports an integrated framework for landscape perception where both internal, cognitive processes and external biophysical or stimuli factors influence perception (Zube, 1982)

As noted by Zube and Sell (1986), landscape perception is a result of the transactions between individuals and landscapes. Human perception is affected by personal utility functions or how the landscape can be used to achieve a goal. It is also affected by a human's needs and desires, as well as social and cultural contexts, including past experiences. As supported by Nieser (1970), the *process* of perception includes the experience and memory of that individual's unique cognitive and transactional history. Affordances influence perception and, at the same time, perception influences affordance.

The stimulus-response framework of landscape perception, sometimes referred to as an 'ecological approach' within the work of Gibson (1979), supports the transactional model as a reciprocal relationship between the perceiver and the environment or landscape (Gibson, 1979). Sallis, Owen and Fisher (2008) do not describe the direct relationship between the environment and behaviour as a defining feature within ecological models, but acknowledge that the environment

can, both directly and indirectly through one's perceptions, influence action. In the context of this research, landscape perception is a product of the transactions between individuals and the environment.

Integral to decision-making or action-taking are the concepts of cognition and compatibility. Referred to as the person-environment fit model (Stokols, 1979) or the person-environment compatibility (PEC) model, Stephen Kaplan (1983) notes there should be compatibility between the environment and one's purposes and inclinations. In other words, the setting must 'fit' what one is trying to do and what one would like to do. This internal process complements Neisser's perceptual cycle (1980) that places action within the process of perception (i.e. perceived affordance leading to actualised or functional affordance).

Perception, then, is a human-based, active, exploratory function utilising information (Gibson, 1979) as provided by the spatial and physical characteristics of the landscape. It is the affordance, the achievement of HWB in this research's context, that governs human actions and transactional relationships within the polycentric, fragmented peri-urban landscape specific to GS. Affordance places perception within the individual's 'here and now'; it addresses the actions of the actual event – the interaction with GS.

5.3.2 Landscape Preference and Affordance

Integral to cognition and perception within the human-environment relationship is the concept of preference. In this research, the term preference includes psychological concepts of opportunity, intent, influence and desire, among others. Landscape preference theories serve to provide insight into the human-based perspective of the physical structure of the landscape - biologically and cognitively - even though not all are completely transactional or functional based. This research will not dwell on this topic, which includes visual preference (Leopold, 1969) and aesthetics (Dewey, 1958; Calvin et al., 1972; Bourassa, 1988; Carlson and Berleant, 2004; Suhardi Maulan et al., 2006) but will discuss how affordance may be a motivational factor behind landscape preference.

Landscape preference theories dominate the environmental psychology literature (e.g. Personal Construct Theory (Kelly, 1955, 1991), Emulation Theory of

Representation (Grush, 2004); Information Processing Theory[24] (Kaplan and Kaplan, 1979); Attention Restoration Theory (Kaplan and Kaplan, 1989); The Savannah Hypothesis (Bartholomew and Birdsell, 1959; Kanazawa, 2014); Biophilic Theory (Fromm, 1964; Wilson, 1984)) and many are stimuli-response or biologically based (Darwin, 1859; Neisser, 1967; Appleton, 1975, 1996; Bailing and Falk, 1982; Bourassa, 1990, 1991).

When utilising the term preference, therefore, it is important to qualify the study – is it aesthetic preference or functional preference, human wellbeing preference or economic preference? (Ward Thompson, personal communication, 2015). Other potentially contaminating factors within visual landscape preference studies include place names signifying special qualities (e.g. Sousa and Garcia-Murillo, 2001) as well as adaptation level theory (Helsons, 1964) and schema discrepancy theory (Purcell, 1986) - both of which account for environmental stimuli and cognitive representation affecting ad-hoc preference responses.

Specific to this research and affordance, landscape preference is the joint effect of specific features of the landscape interacting with relevant psychological (perceptual, cognitive and emotional) processes within the individual (Zube, 1974; Daniel and Boster, 1976; Brown and Daniel, 1987; Daniel, 1990, 2001). In this regard, landscape preference is a dynamic process in which the human-landscape interaction feeds back to both the humans and the landscape. Affordances influence perception and perception influences affordance, at the same time. Integrated within perceived affordance, yet integral to functional affordance, landscape preference is a complex psychological phenomena.

Kaplan and Kaplan (1982) further note that preferred landscapes are those that are understandable: both coherent (orderly) and legible (accessible to finding one's way). In this regard, an individual's preference for a landscape is based on two measurable aspects: landscape content and landscape spatial organisation. Landscape content is the trees, mountains, water and other physical elements within the landscape. Its spatial organisation is simply how these elements are arranged

[24] Information Processing Theories (IPT) state that humans have evolved to perceive and process landscapes through cognitive, mental process as opposed to simple stimulus-response behaviours. Many environmental psychology models and concepts have grown from this framework.

within the landscape. These two aspects provide the basis for understanding many of the physical or spatial landscape factors within the PPUIGS Eco-Spatial Characteristics (See Figure 4.3).

5.3.3 Theoretical Precedents and Landscapes of Affordance

Other theories that do not merit further discussion but may be considered within future research include stimulus-response and behaviourism (e.g. Golledge and Stimson, 1987; Thorndike, 1898), arousal theory (Berlyne, 1960), and phenomenology (Merleau-Ponty, 1962). Most of these paradigms are inclusive of other theoretical frameworks, for example 'prospect-refuge' theory (Appleton, 1975) is a component of attention restoration theory. The concept of landscape preference theory, as well as landscape aesthetic theory (e.g. Lynch, 1960; Lothian, 1999) pervade most theoretical frameworks. The work by Zube et al. (1982) provides an accessible introduction to these topics. Further information can be found within the following, however: Leopold (1933), Crowe (1978), Appleton (1975), Jellicoe (1975), Aiken (1976), Daniel and Vining (1983) and Kaplan and Kaplan (1989).

Cognition, perception and preference were not operationalised measures within this research. Environmental psychological and cognitive studies often focus on elements within the landscape, not the perceptual interaction or spatial cognition (Hart and Moore, 1973). This 'elemental' or object focus results in solely descriptive research, focussed on the 'what' of landscape perception rather than on the 'how' or 'why' (Ward Thompson, personal communication, 2015). Overall, the meanings and motivations behind preference are extremely difficult to quantify, as are the myriad of contextual factors in which perception and preference occurs. Although cognition, perception and preference are integral components of the theoretical construct within this research - affordance theory – they are concepts that have proved difficult to measure accurately and consistently (Lyons, 1983; Zube and Pitt, 1981; Yang and Brown, 1992).

Cognition and perception are only components of affordance within this research's ecological study. In the context of this research's approach, cognition and perception need to be considered, but not identified or measured since the goal

is to explore the transactional relationship between fragmented PPUIGS and HWB, and the achievement of HWB benefits through interaction.

Overall, the factors influencing cognition, perception and preference within the transactional process of achieving HWB through affordance are many and complex. The importance of the process of cognition, perception and preference is that they move the landscape from an internal, abstract representation to an external, functional characterisation for which interaction and affordance occurs and can be more explicitly studied and measured.

For example, Kyttä (2002) applied affordance towards another functional aspect of the landscape – the social aspects of HWB in children such as interaction and bonding. Similarly, Clark and Uzzell (2002) presented the town centre as an important space for teenagers due to the social opportunities it affords. Affordance theory applications are not limited to children's environments; studies have utilised green spaces, rivers and streams, and other natural, semi-natural, semi-urban and urban environments (Said and Abu Bakar, 2005; Roe, 2009).

5.4 Affordance Theory and Human Behaviour

The evidence that GS and nature positively affect HWB is convincing but research is not unequivocal as to the mechanisms or processes that underscore the relationship (e.g., Maas et al., 2008; Van Herzele and de Vries, 2012; Korpela et al., 2014).

The varying stages of human perception and behaviour within the concept of affordance are best summarised by Reed (1993) and Kyttä (2002) and supported by Heft (1989), expanding William Gaver's (1991) four categories of affordances (potential, perceived, utilised and shaped):

Potential affordance –-an opportunity for behaviour offered by an object or environment, may be perceived or not;

Perceived affordance – an opportunity for behaviour offered by an object or environment that has been perceived by the observer but not acted out;

Actualised affordance - an opportunity for behaviour offered by an object or environment that has been perceived by the observer and acted out;

Shaped affordance – observer alters environment in a way to create an opportunity for behaviour.

An example of these aspects of affordance is a low stonewall that offers a possible affordance to sit and rest on it. Interpreting Gibson's deterministic statements, this affordance is an inherent property of the wall - it exists whether it is perceived or interacted upon or not (i.e. Potential Affordance). Chemero (2003) and Heft (2001) disagree, stating that the stone wall provides an opportunity to sit and rest, but it is not an affordance unless that individual perceives it to be a wall for sitting (i.e. Perceived Affordance). Thus the opportunity is external to the observer but the affordance is a property of both the stonewall (i.e. the environment) and the observer (i.e. the individual). Once an individual has interacted with the stonewall, it still remains an affordance (i.e. Actualised Affordance). And if one of the pieces of stone had fallen on the ground, an individual would move the stone back to the wall, thereby creating a functional seating area (i.e. Shaped Affordance).

It is the functional affordance, or Actualised Affordance (Kyttä, 2002) that occurs *after* interaction with a GS has occurred that is of concern within this research (i.e. HWB benefit received through interaction).

Building from concepts of agency and action (Reed, 1993; Pyle, 2002) and 'perceived individual bodily capacities' (Bærentsen and Trettvik, 2002), Kyttä (2004) determined that all affordances include a 'field of action', a certain spatio-temporal point or 'field' between an individual and action (i.e. cognition and behaviour), whereas an actualised affordance (i.e. functional affordance) is achieved through that action. Exactly where this field of action sits within any model of affordance is not clearly determined. In the context of this research, the field of action occurs prior to interaction that results in a HWB benefit (See Figure 5.3).

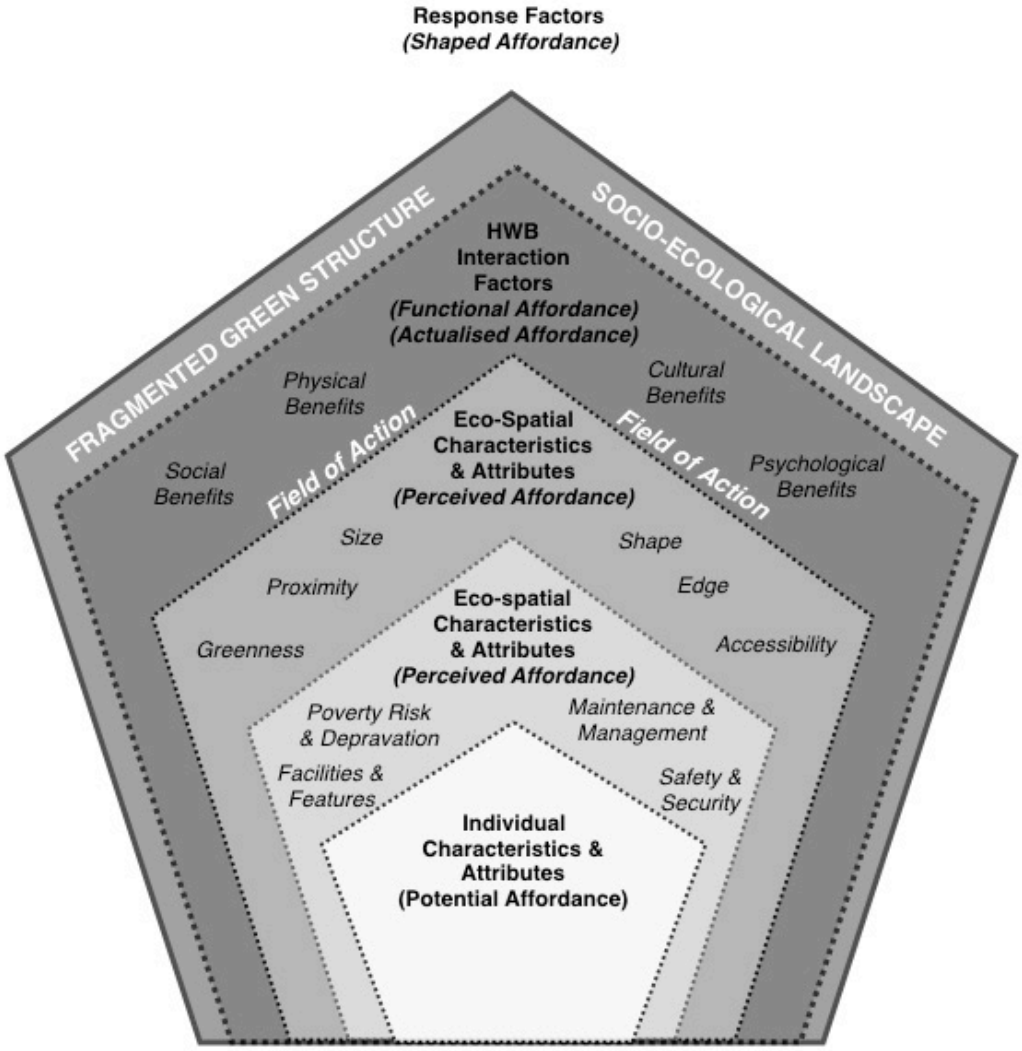


Figure 5.3
Affordance Levels Model

This model illustrates the placement of the varying stages of human perception and behaviour within the concept of affordance as summarised by Reed (1993) and Kyttä (2002).

Although there is an ongoing debate as to the placement of affordances (See Heft, 1989; Kyttä, 2002) specific to where and when the relationship occurs between the individual and the landscape in the affordance paradigm (i.e. potential – perceived – actualised), this research, like Heft's model (1989), allows the affordance transaction to occur at multiple and varied levels. Regardless of placement, it is important to recognise that it is only through an active individual-environment relationship that an affordance can be recognised (See Kyttä, 2002 for

a thorough discussion of affordance placement as well as the concepts of false, hidden, and negative affordances per Gaver, 1991).

5.5 Human Wellbeing Factors within Peri-Urban Landscapes and their Green Space Interaction

Within this research's experimental design for studying the human-nature relationship through transactional-affordance paradigms, and evolving from Kyttä's affordance definitions (2002), five measureable factors influencing humans' ability to achieve wellbeing benefits when interacting with fragmented PPUIGS were identified:

1. Individual Factors

2A. Aspatial Landscape Factors

2B. Spatial Landscape Factors

3. Human Wellbeing (HWB) Interaction Factors

4. Response Factors

These factors work together to influence the use or interaction with the GS and also the reception of HWB benefits in addition to ecological-based benefits as viewed through the landscape services lens. As a group, this complex set of interrelated socio-ecological factors provide both structural and non-structural human-based and GS-based data which was collected (See Chapter 7), analysed (See Chapter 8 and 9), interrelated, and synthesised (See Chapter 10). These factors are expressed in Figure 5.4 - Integrated Affordance Model illustrating Factors of Interaction.

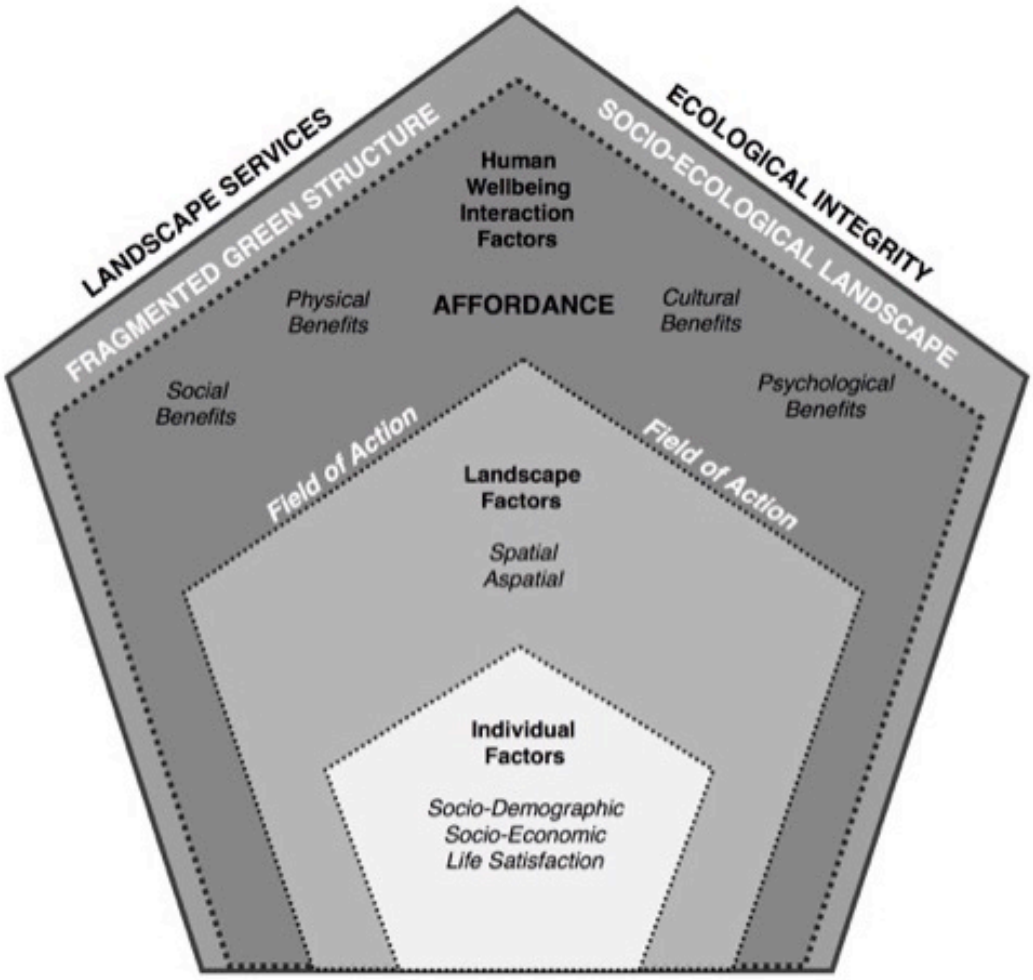


Figure 5.4
Integrated Affordance Model illustrating Factors of Interaction

This model illustrates the influences upon human behaviour when utilising green spaces to achieve human wellbeing benefits.

Elements within the model are adapted from concepts discussed by Heft (1997) and Kyttä (2002).

Within the theoretical frameworks discussed prior, it is important briefly to explain how perceptual representations and cognitive representations interact and how they affect the human-nature relationship. Cognitive theories (Spence, 1950) and perceptual information guides an individual's decisions and actions, and shapes their beliefs. At the same time, knowledge influences the way the world is perceived (Brewer and Lambert, 2001). Both cognition and perception require visual information processing (Marr, 1982).

Landscape perceptions are the conceptual basis from which humans define the value of landscape and thus their potential responses to or actions within PPUIGS. This research's affordance model (See Figure 5.4), therefore, does not remove landscape perception, but rather places it prior to and inherent within the physical action and functional interaction (i.e. field of action). The Integrated Affordance Model's individual-environment framework has been widely used to structure and understand the biophysical environmental factors influencing human behaviour (e.g. Raymore, 2002; Owen et al., 2004; Sallis et al., 2006).

Although other studies have utilised similar mechanisms within behaviour research and environmental design, such as 'behaviour setting' (e.g. Lynch, 1981), this research's approach is comprehensive: it measures both the action or transactional affordance and the environmental setting (i.e. landscape's physical characteristics), thus drawing clear links between action - PPUIGS eco-spatial characteristics and the HWB benefit achieved. In summary, it is the functional affordance often occurring within the 'field of action' that this research measures. The next section shall discuss these factors as shown in Figure 5.4 in more detail.

Factor Group 1 - Individual Factors

The personal attributes of individuals can affect not only their interaction with PPUIGS, but also their affordances received, such as HWB. In social science research, many individual factors have been identified as affecting human interaction with the environment. In regards specific to interaction with GS the literature has noted the following factors: gender (Roovers et al., 2002; Harding, 2003; Giles-Corti et al., 2005), socio-economics (Hung, 2003; Maas et al., 2006), age (Payne et al., 2002; Tamosiunas et al., 2014), ethnicity (Newell, 1997; Gobster, 2002; Morris, 2003; Rishbeth, 2004), education level (Natural England, 2011; Tamosiunas et al., 2014), marital status and employment status (Maat and De Vries, 2003), car ownership (Seaman et al., 2010), dog ownership (Cutt, Giles-Corti and Knuiman, 2008; Richards et al., 2013) and home ownership (Handy, Cao and Mokhtarian, 2006). Appendix 8 provides a short discussion on the viability of

various factors utilised in social-based research within the context of this study.

Most of the studies referenced above provide inconsistent results, making association difficult. Additionally, some studies are poorly designed and do not fully account for confounding variables and bias, leading to weak statistical associations.

Based on literature and existing data, this research will utilise the following individual factors in its experimental design (See Chapter 7 for data collection procedure and further description of factors):

- Age;
- Gender;
- Dog Ownership;
- Car Ownership;
- Household Income;
- Education Level;
- Life Satisfaction.

Participant Age

The desired age for respondents was from 18-75. This range estimates active persons able to utilise GS while also being of age to be documented in the demographic and socio-economic data collected.

Participant Gender

Standard data required for effective analysis.

Household Dog Ownership

Owning a dog predominately requires an interaction with a GS.

Household Car Ownership

Owning a car allows individuals to travel to a GS. Though other forms of transportation exist which also provides this, a car is a standard metric for effective analysis.

Household Income and Eduation Level

Standard data required for effective analysis.

Level of Life Satisfaction Level

Standard data required for effective analysis within the human-nature relationship.

Factor Group 2A - Environmental – Aspatial Landscape Factors

Aspatial Landscape Factors and Human Wellbeing

These factors are similar to individual factors, but are contextual within the individual-environment relationship; they do not reside solely within the individual regardless of the environmental factors. The aspatial landscape factors refer to the qualitative features and characteristics of both the GS and the individual that impact HWB. This research will utilise the following aspatial GS factors within the concept of perceived affordance in its experimental design, with these being discussed in detail in later sections:

- Poverty Risk Ranking;
- Deprivation Ranking.

These are considered standard socio-economic data required for effective analysis (See Chapter 7 for data collection procedure and further description of factors).

Factor Group 2B - Environmental – Spatial Landscape Factors

Spatial Landscape Factors and Human Wellbeing

The spatial landscape factors refer to the quantitative features and physical characteristics of PPUIGS that impact HWB and ecological integrity. These include both Structural and Non-Structural Factors, all which impact GS interaction and reception of HWB benefits. These factors were determined in Chapter 4 and below reflects the PPUIGS Characteristics and Attributes per Figures 4.3 and 4.4:

Structural Landscape Factors

- Size;
- Shape;
- Edge;
- Greenness;
- Proximity.

Non-Structural Landscape Factors
Grouping 1

- Maintenance and Management;
- Safety and Security;
- Features and Facilities.

Grouping 2

- GS Ownership
- GS Titled or Named
- GS Typologial Definition
- GS Special Designation
- GS within Case Study Area SQ Boundary
- Mode of access to GS selected
- Distance to Nearest GS
- Was Nearest GS visited

The Grouping 2 of non-structural landscape factors were secondary data collected after completion of the SQ. Their relevance to GS and HWB is well documented in literature and focuses on issues of accessibility (e.g. Maas et al., 2009, Ulrich 1984), ecological / biophysical qualities, and other GS typological influences (e.g. Ghosh and Head, 2009; Guitart et al., 2012) which are elaborated within the discussion of the results.

Summary – Landscape Factors

Specific to this research, landscapes (i.e. PPUIGS) and their spatial and aspatial factors or characteristics, as well as the individual factors and the concept of HWB benefits, exist due to the dynamic system of mutual influences found within the human-landscape relationship. As noted by Rietveld and Kiverstein (2014), the qualities, properties and characteristics of the landscape or GS are just as important as the behaviours or interactions in any holistic understanding of affordance and this human-nature relationship.

Factor Group 3 - Interaction Factors

Before an engagement or interaction with GS can occur, the complex interaction between individual factors and landscape factors must occur. This transaction to achieve HWB affordances vary according to the individual and the context of the landscape factors.

As discussed previously, affordances are *"perceptual properties in the environment that have functional significance for an individual"* (Heft, 2010, p. 18). Affordances are clues in the landscape that indicate possibilities for action, particularly physical action or interaction, but also include passive interaction (Kyttä, 2004) such as observation or viewing, for example sitting on a rocky promontory that offers an expansive view of the landscape.

This research utilised a public participation data collection methodology to collect data whereas a pruposeful action or interaction within a GS was coded to reflect one of the three HWB benefits, or here, affordance (See Chapter 7):

- Physical Wellbeing;
- Psychological Wellbeing;
- Social Wellbeing.

Factor Group 4 - Response Factors

Within this research, a response factor is an intentionally modified action or behaviour that leads to functional affordance - HWB. The key aspect of this research's affordance is a behaviour or action prior to the transaction with the intent of achieving HWB benefits through that relationship. This is a subtle yet important concept within the human-nature relationship specific to spatial planning's and landscape architecture's influence toward HWB.

Within Affordance Theory, the individual is an active and integral participant of landscape change. In this regard, the PUL exists within a constantly changing, cyclical state, in which the landscape is changing and in which people independently affect that changing landscape, thus requiring a response or mediation in order to maintain, improve or even negate affordances.

Although response factors have not been operationalised in the experimental design of this research, this term refers to the design and management actions upon the landscape as spatial-based mediated actions, as well as policy such as planning.

This factor group specifically reflects those aspects found wthin the DPSIR model's 'Response' grouping. This research will, however, utilise the following response factors within the concept of transactional behariours and HWB affordances and is discussed specifically in Chapter 10:

- Spatial Planning;
- Landscape Architecture;
- Landscape Management;
- Policy.

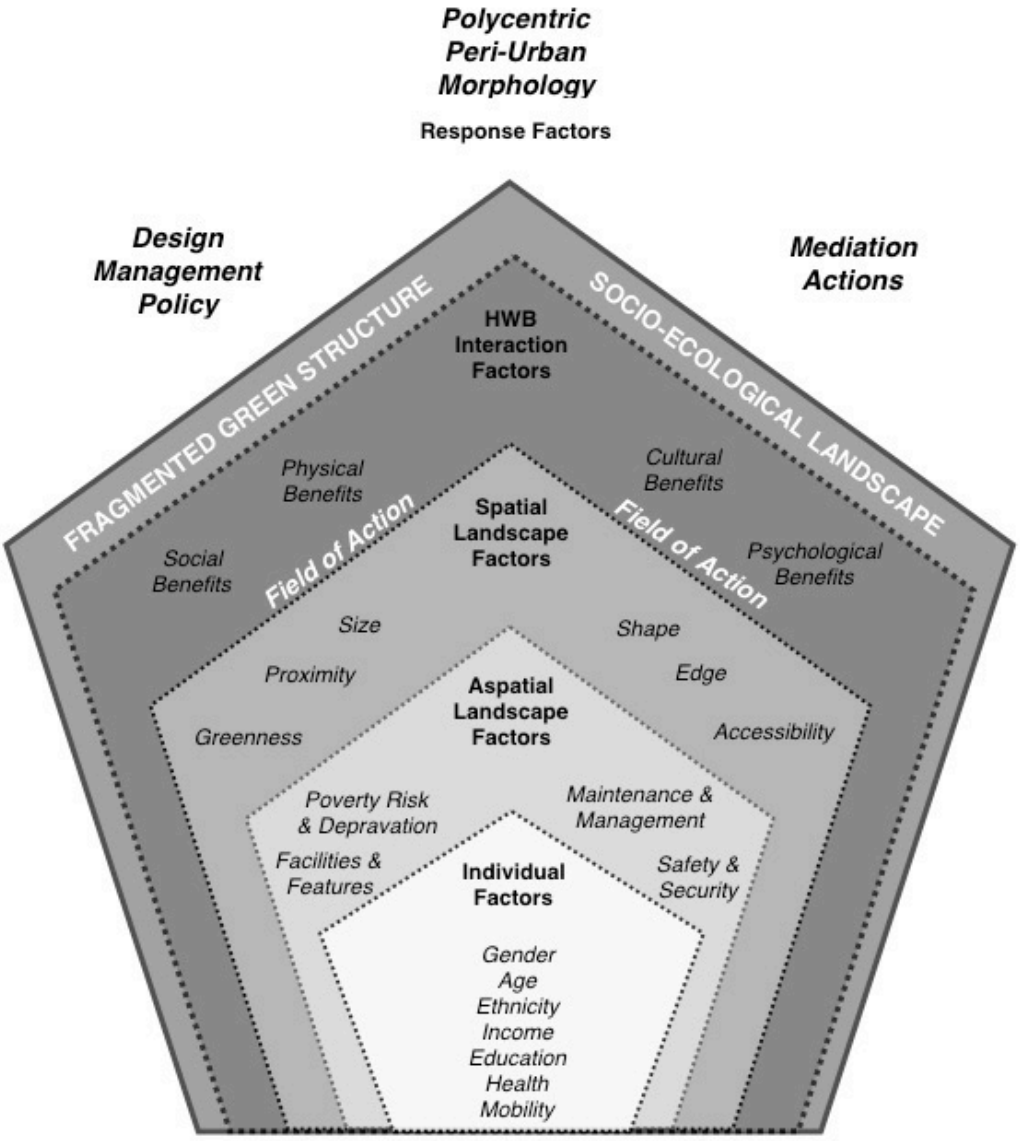


Figure 5.5

Socio-Ecological Interaction Factors
Within the Conceptual Integrated Affordance Model

Model exploring the influences upon human behaviour when utilising green spaces in order to achieve human wellbeing benfits

Figure 5.5 places the five factors influencing the benefits to an individual's wellbeing achieved when interacting with PPUIGS. This diagram provides a valuable tool that integrates often disparate and independent elements within HWB and GS studies, highlighting the importance of socio-ecological influences found within PULs and documented within the PPUIGS Characteristics Performance Index in Figure 4.3. In this regard, this research's multiple variables and factors – Individual Factors, Landscape Factors (Spatial and Aspatial), and HWB Interaction Factors – are analysed through an individual's interaction with PPUIGS. The physical features of a GS and the benefits achieved by individuals interacting with those GS, as well as the individual's characteristics, provide a more direct means to investigate and measure this relationship (Giles-Corti, 2006) and the GS's performance.

This research operationalised a hetarchical group of eco-spatial PPUIGS indicators that (e.g. Size, Shape, Edge, Accessibility, etc), together, served as a conceptual proxy for the positive interactions specific to fragmented landscapes and GS within PolyPURs that contribute to both the ecological (i.e. ecological integrity) and socio-cultural aspects (i.e. human wellbeing) of functional landscape dynamics (See Figure 4.3 - PPUIGS Characteristics Performance Index). The PPUIGS Characteristics Performance Measurement Index (Figure 4.4) provided a set of measurable physical attributes. By understanding the context of the PPUIGS within these transitional landscapes, PolyPURs can better manage spatial planning and design strategies to provide landscape services.

5.6 Landscapes of Affordances

As a new concept, the term landscape of affordances (See Figure 5.6) evolved from the functionalist-based Theory of Affordance within this research's context in viewing performance-based landscapes. Landscape Affordances include both ecological-based affordances (i.e. biophysical) and socio-cultural based

affordances (i.e. anthropological). Ecological-based affordances articulate the dynamics of ecological patches that lead to ecological integrity. Socio-cultural affordances provide the landscape's GS spatial and aspatial characteristics that lead to direct and indirect HWB benefits. As such, it is this unique socio-ecological landscape – a Landscape of Affordances – found within PolyPURs that provide an integrated set of benefits to both humans and nature – or Landscape Services.

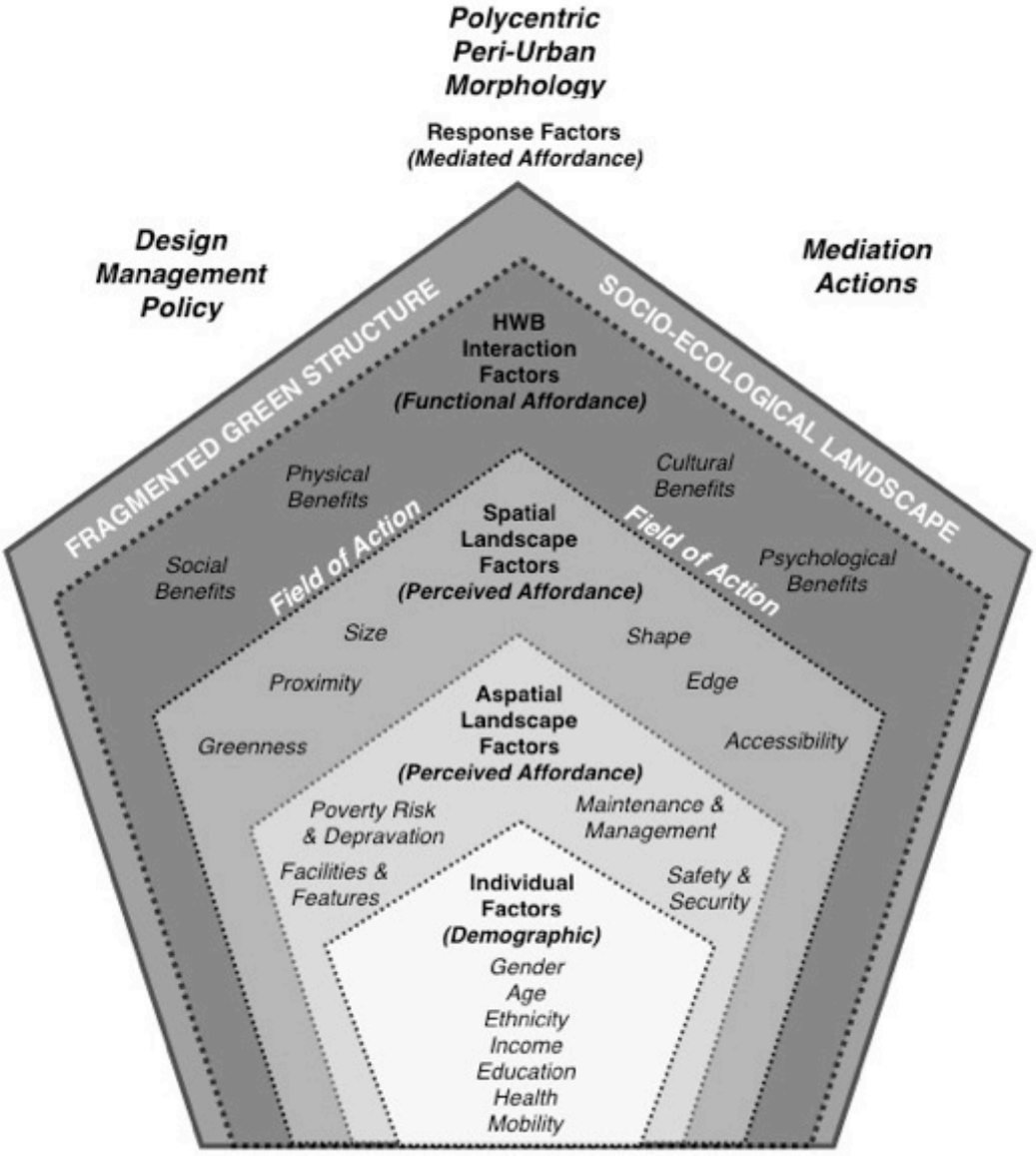


Figure 5.6

Conceptual Landscapes of Affordance Model within Socio-Ecological Polycentric, Peri-Urban Green Spaces and Green Structures

This conceptual framework integrates spatial form, green space and social dimensions of human and ecological functionality within distinct polycentric, peri-urban landscapes to model Landscape of Affordances and Human Behaviour/Interaction.

Affordances within the landscape are physically tangible, and the process of physical engagement provides a mechanism to more objectively measure this interaction than traditional perception and cognitive based measures (i.e. abstract measures). They key concept within any affordance based study is to remove perception and meaning to the highest degree possible. Whether environmental meaning or individual value-based meaning, actions must be separated from construing meaning.[25] This is difficult and no strong methodology exists that can assess landscapes of affordance as comprehensively required. The methodology applied in this research, however, i.e. SoftGIS, correlated physical, eco-spatial qualities to an individual's subjective meaning – HWB benefit received - through behavioural interaction (See Chapter 7).

A landscape's HWB affordances are its meanings considered from a functional standpoint for an individual. That meaning, or benefit, only exists in *that* moment for *that* individual and, for *this* research, to *that* GS, in *that* state of landscape fragmentation. A landscape of affordance provides a functionally meaningful transaction to the individual, but this must be construed subsequent to the action, not before. As noted by Heft (2001) and Coolen (2005), individuals selectively engage particular spaces in the landscape; typically making choices from among the range of potential features and eco-spatial attributes in a setting to support some intended activity. This self-selection of affordances and behaviour-settings (i.e. landscapes) also has social and/or cultural constraints beyond the intended benefit from interaction.

Landscapes of affordances cannot be reduced to synomorphs or behaviour-settings; they are more synergistic and multi-functional. Although they are limited by an individual's functional capacities, as well as the landscape's current available physical characteristics, it is the intentionality of action found within their direct

[25] See Glenberg & Kaschak 2002

transactional reciprocity that separates this concept from others (e.g. environmental determinism or behaviouralism).[26] Landscapes of affordances and their reciprocity allow for exploration and discovery within such constraints; finding novel uses for familiar objects and spaces is a particularly satisfying way for new affordances to be discovered. Rietveld and Kiverstein (2014, p. 330) state that humans embedded in a landscape of affordance develop specific skills and capacities or 'situated normativity', thereby enacting the individual-landscape affordance relationship. Thus, landscapes of affordance are both an eco-spatial property/quality *and* an interpersonal property/quality: they cannot be considered an affordance independently, and, significantly, relatively.

The transactional paradigm as expressed within affordance theory provides a means to measure explicit 'in-situ' actions which are 'ex-vivo' or outside the 'in the brain' processes of cognitive psychology. This research's operational affordance model provides for clear subjective (i.e. contextual) and objective (i.e. transactional) experiences within the landscape and is useful for the study in determining the functional properties of the PPUIGS, and how individuals use the landscape and its GS to enhance their physical, social and psychological wellbeing.

5.7 Landscape of Affordances Summary

It is through Affordance Theory that a more comprehensive understanding of HWB – GS interaction is achieved. The concept of a socio-ecological landscape - or PUL - emphasises the interconnectedness of the biological and biophysical processes of ecosystems, and the cognitive, socio-cultural and institutional processes of human systems (Berkes and Folke, 1998). This interconnectedness is still poorly understood and often unacknowledged. What is clear, however, is that loss and degradation of ecosystem function through urbanisation and landscape fragmentation has complex consequences for a landscape as a whole (Folke, 2006; Maltby and Acreman, 2011), including humans.

These eco-spatial impacts of landscape fragmentation to HWB are not well known within the social sciences and other disciplines. Alternatively, the

[26] Preferences and perceived congruence are not given priority over interaction within the landscape of affordance framework – rather a beneficial outcome to the transaction is.

mechanisms for achieving ecological integrity are well studied, often focussing on connectivity and but what is a human's best operational space? What are those specific biophysical, spatial characteristics for humans to achieve the best performance in physical, social and psychological wellbeing? Do humans perform and function best in a physically connected GS PUL or one more spatially heteregenous? This research seeks the highest functional GS for both HWB *and* ecological processes; these important aspects require further study.

Chapter 6 - Research Strategy and Methodology

6.1 Research Objectives and Research Questions

The overall purpose of this research is to explore the human-nature relationship found within the evolving socio-ecological landscapes of polycentric, peri-urban regions within Europe and the specific effects spatial fragmentation of interstitial green spaces has upon human wellbeing.

The research objective is to relate the characteristics of GS fragmentation – its physical structure, patterns and form – to HWB in order to gain a better understanding of both the human and the eco-spatial factors that affect this relationship. The literature has noted the negative impacts of landscape fragmentation upon ecosystems and ecological integrity. But much less is known about the human-based impacts; although the assumption tends to be that this impact is negative as well.

The hypothesis generated for this research posits:

> *Hypothesis: The fragmentation of green spaces found in polycentric peri-urban regions of Europe negatively affects the production of wellbeing benefits to humans.*

The research methodologies selected will answer both the hypothesis and the specific research questions formulated in Chapter 1. These are restated:

1. *What are the specific spatial attributes and physical characteristics of peri-urban green spaces and green structures within a polycentric region in a fragmented state?*
2. *Which are the types and what are the physical characteristics of spatially fragmented green structures within polycentric peri-urban landscapes that are conducive to particular human well-being benefits (e.g. psychological, social and/or physical wellbeing)?*
3. *What types of people use what types of green spaces and green structures polycentric peri-urban landscapes for what types of human wellbeing benefits?*
4. *What type of peri-urban green space assemblages provide the most affordances or highest performance aspects to human wellbeing measures and ecological integrity?*
5. *How can landscape planning and design in the context of dynamic polycentric urbanising landscapes contribute to improving human wellbeing?*

6.2 Research Strategy and Methodology Overview

This Chapter presents the research methods and techniques through which the research questions will be explored and answered and the research hypothesis confirmed or denied. The human-nature interaction is complex and diverse and, to reflect this, the research adopted a mixed-method strategy including quantitative and qualitative means of enquiry, measuring both spatial and aspatial quantifiable data. It is landscape services and the concept of comprehensive benefits beyond ecological function and processes that allow this research to examine the human-nature relationship within the context of the polycentric, peri-urban landscapes and their GS through the integrated and transactional perspective found within Affordance Theory. The two primary research instruments employed within the comparative case study methodological framework are a spatial landscape analysis and a social analysis or survey questionnaire.

6.3 Mixed-method Research

A mixed-method strategy to research is common in the social sciences (Tashakkori and Teddlie, 1998; Bryman, 2008; Cresswell, 2009), is appropriate for interdisciplinary analysis (Creswell and Clark, 2007), and provides improved validity (Morse and Field, 1995; Johnson et al., 2007; Tashakkori and Teddlie, 2010) as well as comprehensive and complementary data (Risjord, Dunbar and Motoney, 2002). Multiple research methodologies can lead to comprehensive results; and Johnson et al. (2007, p. 129) have remarked that such a research approach "*…will provide the most informative, complete, balanced and useful research results.*"

Criticisms of utilising a mixed-method approach are often centred on its philosophical and theoretical underpinnings (Guba and Lincoln, 2005); specifically, an individual's objective, 'external reality' cannot be measured through subjective qualitative methods (Lather, 1992). The interdisciplinary focus of this study requires data from a range of sources and perspectives that can be measured and analysed convincingly as a whole. The mixed-method approach adopted here, therefore, builds a solid discussion through a diverse yet complementary dataset that is both internally and externally valid.[27]

6.4 Interdisciplinary Research through the Pragmatic Paradigm

Research within the context of interdisciplinary and transdisciplinary fields of study require clear paradigms from which to construct a methodology and provide unambiguous results to both quantitative and qualitative data. Although any paradigm's methodological construct provides thorough analysis from its own respective position (See Chapter 1), this research required a mixed-method and multi-method approach to effectively synthesise the data and results. The paradigm of 'Pragmatism',[28] as first developed by Charles Sanders Pierce in the late 19th

[27] In the context of this research, the word 'methods' follows the Johnson et al. definition (2007, p.118): "a broad interpretation and use of the word methods (in mixed-methods) allows inclusion of issues and strategies surrounding methods of data collection (e.g., questionnaires, interviews, observations), methods of research (e.g., experiments, ethnography), and related philosophical issues (e.g., ontology, epistemology, axiology)".

[28] Additional information regarding the concept of pragmatism can be found within the work of philosophers Peirce (1878), James (1907), Mead (1932), and Dewey (1929).

century, recognised the philosophical foundation of the observer/actor within its outcome-focused epistemology. Pragmatism reduces interpretation of thought (e.g. preference) and abstract concepts, in favour of cognitive thought towards action and outcome (Johnson and Onwuegbuzie, 2004). In this sense, pragmatism supports and complements the Theory of Affordance utilised in this research. Pragmatism's framework of knowledge emphasises practical solutions to the applied research questions.

Pragmatism is not without its limitations. Johnson and Onwuegbuzie (2004) note that pragmatic research may elicit incremental change rather than more wide-spread, fundamental or theoretical alteration. Additionally, the clear application of a functional outcome or use is based on interpretation.

In summary, this research moves beyond the aesthetics and form of GS to investigate the human-nature relationship from a pragmatic and functional perspective. This is a human-centred approach to planning, design and management requiring insight into the interaction between people and their environment, answering complex problems through an interdisciplinary approach.

6.5 Research Theoretical Framework

This research's investigative methodology is based upon the theoretical framework of the affordance-based paradigm (See Chapter 5) and thus moves beyond mental constructs or cognitive concepts of preference and perception to account for the normative function of GS as indicated through use and interaction. Behavioural observation (e.g. Barker, 1968; Golicnik, 2005) is not a method operationalised in this research since, while behaviour can be objectively observed and recorded, there was no effective, continuous, and safe means to collect the user data required in-situ. Additionally, it is not possible to accurately measure the affordance received through direct observation, particularly multiple benefits from the same behaviour or action (i.e. synergestic effects). Furthermore, behavioural observation often provides indirect measures towards cognitive benefits, which reduces validity. For this reason, direct and indirect behavioural observation is excluded from the research's methodological framework.

6.6 Research Methodology

This research's mixed-method approach applies data collection and analysis in both simultaneous and sequential order, with each data collection and analysis phase being complementary and interdependent (See Figure 6.1 - Methodological Framework). Although quantitative data was collected first, both the qualitative and quantitative data were weighed similarly to answer the hypothesis and research questions.

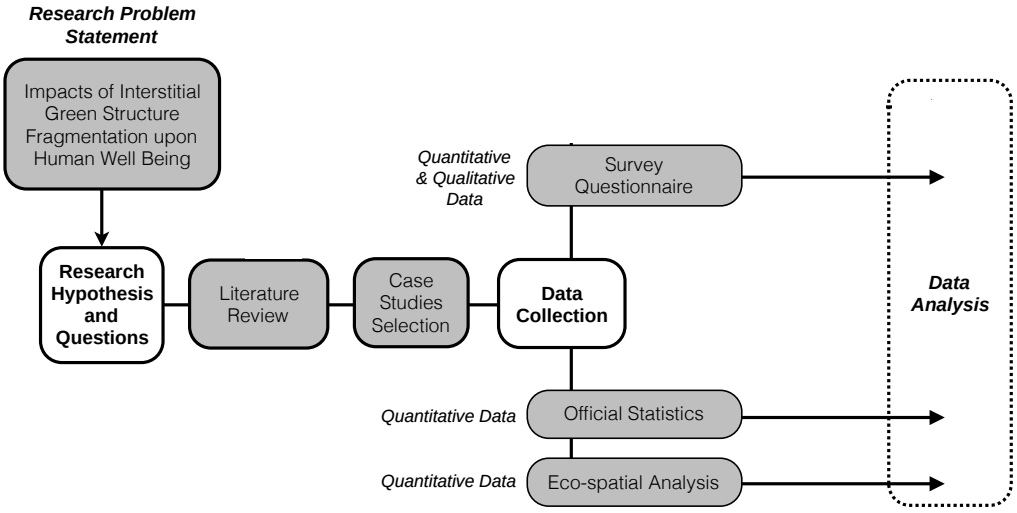


Figure 6.1
Methodological Framework
The methodological framework of this research used a combination of quantitative and qualitative data collection and analysis instruments within a mixed-method, interdisciplinary paradigm.

This research's quantitative and qualitative approach is complementary, with the quantitative data considering the 'why' of the polycentric region's morphology (i.e. spatial characteristics of fragmented GS as 'physical' evidence) and the qualitative data the 'how' of the polycentric region's morphology (i.e. socio-demographics and the cultural interaction as 'HWB' evidence) in order to better comprehend this relationship.

The literature presents a myriad of methodologies and instruments (quantitative and/or qualitative) utilised in research studies of GS and HWB or LS, particularly related to the experiences, attitudes and perceptions of GS (e.g. hedonic

pricing per Kolbeand and Wüstemann, 2014 & Dembrowski and Kronenberg, 2016), but few specific to the actual use of GS themselves.

6.7 Strategy for Data Collection and Analysis

This research selected the following strategies to explore the HWB – GS relationship and operationalise the research to meet the objectives of the study through a case study approach (Francis, 2003; Swanwick et al., 2003; Kong et al., 2007; Ahrentzen, 2008; Uuemaa et al., 2013):

- Case Study Spatial Landscape Analysis operated through a physical or eco-spatial analysis specific to landscape and GS fragmentation (Gosling, 1993; Dramstad et al., 2001; Bright et al.; 2002; Herzog et al., 2002; Nassauer, 2004; Tyrväinen et al., 2007; Pham et al., 2012; Miller and Morrice, 2014);
- Case Study Socio-Cultural Landscape Analysis operated through a survey questionnaire (SQ) (Ulrich, 1984; Kaplan and Kaplan; 1989; Zeisel, 2006; Ward Thompson et al., 2012; Tyrväinen et al., 2014; Chou et al. 2016).

Each strategy collected different yet complementary data to studying this research's unque human-nature relationship of PPUIGS and HWB. It is through a comprehensive analysis and understanding of the various factors that work together to not only influence the use or interaction with the GS but also the reception of HWB benefits that is key to this research strategy.

6.8 Methodology Summary

This Chapter has described the research strategy employed to test the hypothesis and to explore and answer the research questions posed; it describes the theoretical structure and the methodological design for the research within a multi-method approach to collecting quantitative and qualitative data.

This research's methodology including DPSIR supports the approach to model complex entities created by the multiple interaction of components *"by abstracting certain details of structure and component, and concentrating on the phenomena that define the characteristic functions, properties, and relationships that are internal or external to the system."* (Laszlo and Krippner, 1998).

As integrated frameworks, the PPUIGS Characteristics Performance Index in Figure 4.3 collectively represents the relationship between the PPUIGS' physical characteristics and the *direct and indirect* landscape services specific to HWB that can be explicitly measured and evaluated.

In summary, each methodological approach of this research can be used under dissimilar circumstances to elucidate a different aspect of the PPUIGS-HWB relationship. One approach or one method can only provide partial insight to this complexity. The application of a mixed approach using varying and multiple methods allows a more holistic understanding (Dures, 2011; Irwin, 2006) of this human-nature relationship and serves as a platform to generalise the results and methodology to other similar regions in Europe and beyond. The next Chapters will enact each methodology in turn and report the associated results.

Chapter 7 - Research Strategy: Case Study Analysis

7.1 Strategy for Case Study Data Collection and Analysis

This Chapter provides an overview of the theoretical and methodological approach to this research's use of case studies to collect data.

The two selected case studies for this research were the polycentric urban regions (PUR) of the Greater Glasgow Urban Region (GGUR), encompassing Glasgow, Scotland, and the Helsinki Urban Region (HUR) surrounding Helsinki, Finland. A specific polycentric sub-centre was selected within each of the two PUR's conurbation that met the research criteria: Paisley, within the GGUR and Vantaa, within the HUR for the specific case study areas (CA).

Overall, the CAs provided the context for the data collection of the spatial or landscape characteristics and aspatial or socio-cultural characteristics, including their geographic form and the landscape qualities or physical characteristics specific to their PPUIGS and fragmentation. The case study approach provided the context for primary data collection and was separated into two distinct yet complementary studies: the spatial landscape analysis (See section 7.3) and the socio-cultural landscape analysis (See section 7.4):

- Spatial Landscape Analysis: Physical characteristics of fragmented PPUIGS (through HardGIS);
- Socio-Cultural Landscape Analysis: Individual characteristics and HWB benefits afforded through Fragmented PPUIGS interaction (through SoftGIS – Survey Questionnaire).

These analyses provided two distinct yet interrelated sets of results – the human-based or demographic and socio-economic data and the landscape based or PPUIGS characteristics – which are both structural and non-structural.

The case study analysis was partially operationalised through the DPSIR model (See section 8.5), which provided a framework through which to structure data collection specific to understanding the complex process of PPUIGS fragmentation due to urbanisation and resultant impacts to HWB. Though DPSIR is distinctly a modelling framework, its unique approach fulfils a methodological

technique to capture the dynamic phenomena of the human-nature relationship as part of the data collection and exploratory analysis, particularly the PPUIGS fragmentation process for each region and sub-centre of the two selected CAs.

7.2 Case Study Introduction

Case studies are utilised to study complex relationships within a unique, real-life context (e.g. Neuman, 2000) and can be applied to theoretical concepts. Case studies are a type of evidence-based research and are well respected within the domain of evaluation and applied research methodologies (Ahrentzen, 2008). Case study methodologies prescribe empirical and critical analyses through a structured approach.

Case studies are used *"… extensively in social science research (…) as well as practice-orientated fields such as urban planning, public policy…"* (Yin, 2003: xiii). Mark Francis (2003) studied the applicability of using case studies in landscape architecture, and defined a case study as: *"… a well-documented and systematic examination of the process, decision-making and outcomes of a project, which is undertaken for the purpose of informing future practice, policy, theory, and/or education." (p.9)* The case study approach is a useful technique to conduct a thorough study of a particular phenomenon. As noted by Cohen (2007), case study research design provides examples of real-world situations, enabling effective communication to a variety of disciplines and stakeholders. Additionally, case study research, when associated with survey data, presents a clearer perception of the research issue (Bell, 1999).

Case studies are a valued approach to landscape architecture research and Dening and Swaffield (2011) support the strength of a case study strategy within the complex relationships inherent in socio-ecological or hybrid system processes. Additionally, comparative methodologies utilising case studies, specifically geographical contexts, are an effective strategy within spatial and temporal variabiliy (Gerring, 2007).

7.2.1 Case Study Polycentric Urban Regions: Greater Glasgow Urban Region, Scotland and Helsinki Urban Region, Finland

PURs differ from other urban regions in both spatial and functional morphologies (i.e. form, structure, changeability). As discussed in Chapter 3, *polycentricity*, in the spatial planning and land use development domain, has specific connotations. Specifically, polycentric areas are an inter-regional concept with land use development patterns occurring in a dispersed character and concentration across the growth area (Study Programme on European Spatial Planning - SPESP). Both the GGUR and HUR are morphologically polycentric.

The objectives of this research required the identification of PURs that are currently undergoing the urbanisation process and exhibited the associated impacts of IntGS fragmentation. This analysis confirmed that these two PULs and their GS exist in a fragmented state.

7.2.2 Case Study Areas Facts and Figures

This section provides a brief overview of the location of each of the case study areas, their PolyPURs (See Figure 7.1 – PUR Locations), its core city, and associated larger urban zone, and the specific peri-urban sub-centre or CA utilised in this research to collect data.



Figure 7.1
The Case Study PURs Location within the European Union
(source: http://wwp.greenwichmeantime.com/time-zone/europe/european-union/map/)

Case Study Area #1 - Glasgow and the Greater Glasgow Urban Region, Scotland

Glasgow

Glasgow is located on the River Clyde in the eastern portion of Scotland, in the West Central Lowlands. Glasgow is located about 42 miles or 67 km west of Edinburgh, 556 kilometers or 345 miles northwest of London, 294 kilometers or 183 miles northwest of Manchester and Liverpool, and 308 km (191 mi) east of Dublin, Ireland. (See Figure 7.2 – Glasgow, Scotland Location Map)



Figure 7.2
Glasgow, Scotland Location Map

Glasgow is the second northernmost capital in the world, located on the 55th latitude, similar to Moscow. Though often wet throughout the winter, average temperature in Glasgow is 18° C in summer and 3° C in winter, daytime and nighttime temperatures combined. Daylight conditions vary dramatically: there are 7 hours of daylight (the sun stays above the horizon) on the shortest day in winter, and 17 in the summer. On Summer Solstice, the sun sets at 11:34 pm, and the summer sky never becomes completely dark.

Glasgow is part of the Glasgow City administrative council. The 2015 population for Glasgow, per the Glasgow City Council boundaries, was estimated at 599,855 (UK Population, 2016). The last Census in 2011 provided a total of 592,820 (National Records of Scotland 2011). Since 1986, Glasgow City's total population fell overall while Scotland's population rose this period (National Records of Scotland). The European Union's statistical body Eurostat (2010) listed Glasgow as the 32nd most populous metropolitan area in Europe.

Glasgow is the largest and most dense city in Scotland. Glasgow is the third largest city in the United Kingdom after London and Birmingham. The City of Glasgow municipal boundaries are 213.75 km² with a 2013 estimated population of 593,245 individuals. This resulting population density of 2,775.42/km² is the densest in Scotland and 4th in the UK (Geographist Wordpress, 2013)

Greater Glasgow Urban Region

Glasgow forms the core of the Glasgow City Region and the Greater Glasgow Urban Area. The Glasgow City Region is defined as the 8 municipalities of Glasgow City, East Dunbartonshire, West Dunbartonshire, North Lanarkshire, South Lanarkshire, East Renfrewshire, Renfrewshire, and Inverclyde. Essentially encompassing those municipalities that physically border the City of Glasgow (i.e. Glasgow City) boundary (See Figure 7.3).



Figure 7.3
Greater Glasgow Urban Region Location Map

The Glasgow City Region has a total population of 1,787,515 (2011) inhabitants, land area of 3,346 km2 (CityProfiles, 2012) and a population density of 534.22/km². The Glasgow City Region is also referred to as 'Metropolitan Glasgow', the 'Glasgow and the Clyde Valley' and 'Clydeside'. The European Union identifies the very similar area (i.e. continuous urban area surrounding the City of Glasgow) as the Glasgow Metropolitan Area (Eurostat), however, the UK and Scotland does not recognise the Glasgow City Region with 'metropolitan status'.

Another notable physical designation utilised in spatial planning for the Glasgow region is the Greater Glasgow Urban Area. Though this region is difficult to spatially define, it generally includes those urbanised areas and city-regions physically attached to Glasgow City. When viewed comprehensively, these urbanised regions create a single, continuous urbanised area, or conurbation (Scottish Government Urban/Rural Classification, 2013 – 2014).

Though the Greater Glasgow Urban Area's physical designation is somewhat malleable and fluid, recent planning documents note North and South

Ayrshire, Falkirk, and Stirlingshire as being ‘commuter towns, and thus inclusive in the Greater Glasgow Urban Area. Furthermore, it appears the term Greater Glasgow Urban Area was first defined by the NHS and has since become commonplace in all disciplines. As such, no agreeable definition or physical boundary exists for the Greater Glasgow Urban Area. For the context of this research, the Greater Glasgow Urban Area, based on Council boundaries, including the commuter municipalities, has a total population of 2,285,375 (2011) inhabitants, land area of 7,936 km2 and a population density of 288/km² shall be referred to as the Greater Glasgow Urban Region (GGUR). At almost 2.3 million people in population, the GGUR encompasses almost ½ of Scotland’s total population (2011) (See Table 7.1)

Glasgow suffered and is still suffering from the effects of post-industrialization (GCPH, 2008), specifically intra-urban population decline (exurban migration), and is frequently cited as one of the major underlying reasons behind the poor health profile of Scotland. Subsequently, Glasgow and its outlying landscape have experienced heavy urban growth, mostly due to outmigration (Johnson and Schultz, 2011).

In November 2012, Glasgow was judged the worst Scottish city in a report grading cities on economic success and quality of life (PricewaterhouseCoopers’ Good Growth For Cities). Glasgow has the lowest life expectancy of any UK city and has higher levels of obesity, diabetes, and alcohol consumption than the rest of the country (Glasgow Centre for Population Health). Unique to this city is the ‘Glasgow Effect’; a term to describe the poor health status of Glasgow over-and-above that attributable to the city's high levels of socio-economic deprivation.

In 2010, Glasgow was ranked 57th by the Mercer Quality of Living Ranking. Glasgow is ranked 55th in the Global Cities Quality of Living Index (2012). Only 35.9% of Glasgow residents rated their neighbourhood as a very good place to live in 2007/08 (Glasgow Economic Partnership). Additionally, Glasgow ranked 19 of 20 on the UK’s Sustainable Cities Index and in 2010, this same Index listed Glasgow as 18th (of 20) in Quality of Life where it was 20th in 2008.

Municipality	**Area**	**Population** *(2011 Census)*	**Population density**
Glasgow City	213.75 km²	593,245	2,775.42/km²
East Dunbartonshire	175.01 km²	105,026	600.11/km²
West Dunbartonshire	159.01 km²	90,720	570.53/km²
North Lanarkshire	470.08 km²	337,727	718.45/km²
South Lanarkshire	1771.55 km²	313,830	1,771.15/km²
East Renfrewshire	173.01 km²	90,574	523.52/km²
Renfrewshire	261.08 km²	174,908	669.94/km²
Inverclyde	160.01 km²	81,485	509.25/km²
Glasgow City Region *(Metropolitan Glasgow)*	***3,346 km2***	***1,787,515***	***534/km²***
Commuter towns (North Aryshire, South Aryshire, Falkirk and Stirlingshire)	4,589.95 km²	497,860	169.10/km²
Greater Glasgow Urban Region	***7,936 km²***	***2,285,375***	***288/km²***

Commuter Towns
Falkirk - area = 297.08 sq km, population = 157,640
South Ayrshire - area = 1222.47 sq km, population = 112,510
North Ayrshire- area = 884.98 sq km, population = 136,450
Strilingshire - area = 2185.95 sq km, population = 91,260

Source: Glasgow census, 2011
http://www.scotlandscensus.gov.uk/census-results

Table 7.1
Greater Glasgow Urban Region
Area, Population, and Population Density Statistics

Peri-Urban Conurbation

The GGUR contains the following four polycentric sub-centres: Paisley (84,330 inhabitants, 2011), East Kilbride (74,395 inhabitants, 2011), Hamilton (53,188 inhabitants, 2011), and Coatbridge (43,841 inhabitants, 2011) (See Figure 7.4 and 7.5). These four sub-centres represent the first, second, third and fifth largest town-designated areas in Scotland (See Figure 7.6).

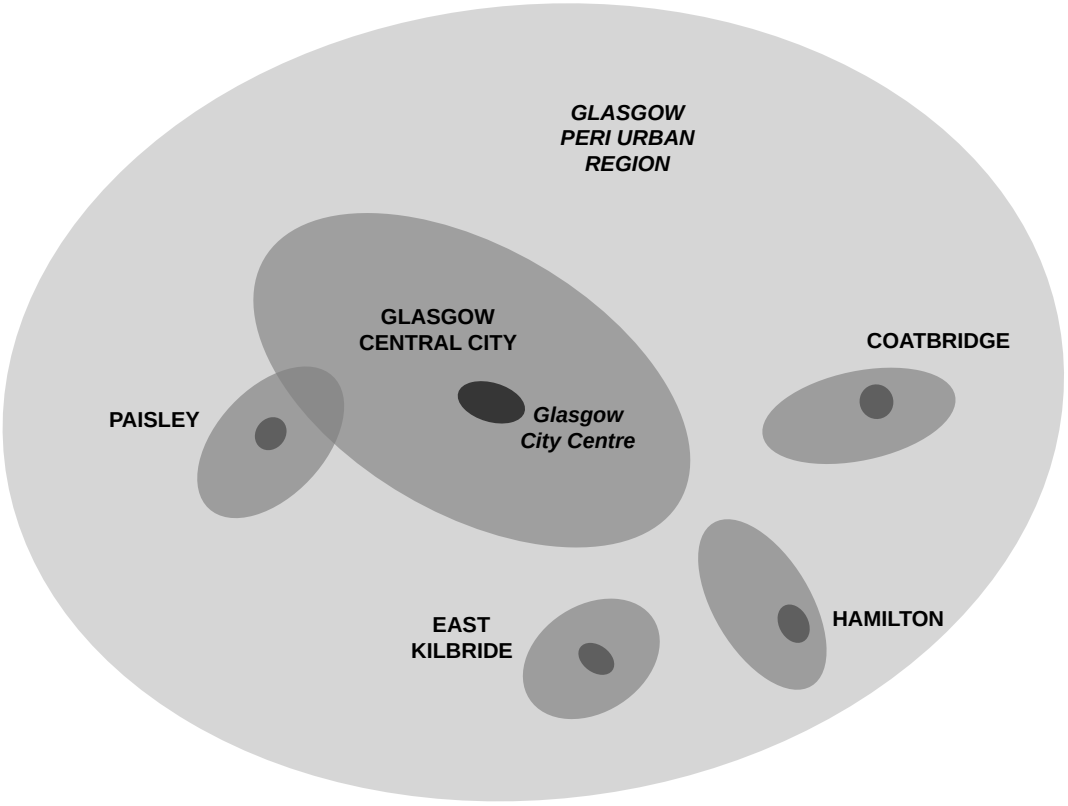


Figure 7.4
Greater Glasgow Urban Region Polycentric Diagram
(Abstracted Physical Connectivity Field representing Morphological Polycentricity)

Grey areas indicate urban population density, lighter areas are less densely populated areas. No density metrics are known, this is a diagram only to show the morphological spatial relationship between the urban areas only.



Figure 7.5

Greater Glasgow Urban Region Conurbation Diagram
(Spatially Appropriate Physical Connectivity Field representing Morphological Polycentricity

Grey areas indicate urban population density, lighter areas are less densely populated areas. No density metrics are known, this is a diagram only to show the morphological spatial relationship between the urban areas only.

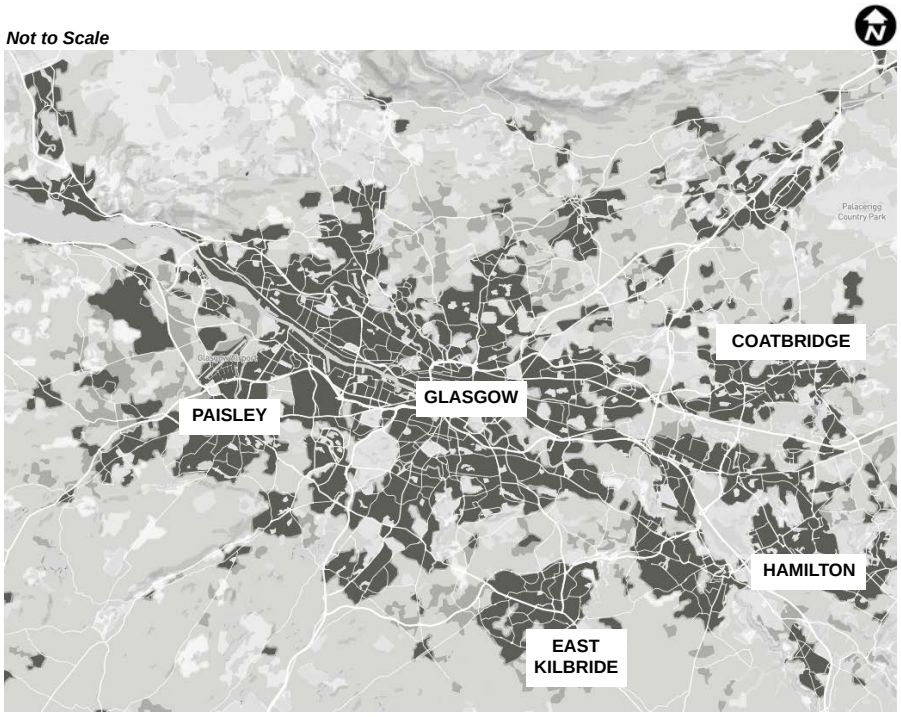


Figure 7.6
Greater Glasgow Urban Region Conurbation

Grey areas indicate urban population density, lighter areas are less densely populated areas. No density metrics are known, this is a diagram only to show the morphological spatial relationship between the urban areas only.

Case Study Area #2 – Helsinki and the Helsinki Urban Region, Finland

Helsinki

Helsinki is located on the shore of the Gulf of Finland, which is adjacent to the Baltic Sea. Helsinki is in the southern portion of Finland, in the region of Uusimaa. Helsinki is located about 80 kilometres (50 mi) north of Tallinn, Estonia, 400 km (250 mi) northeast of Stockholm, Sweden, and 388 km (241 mi) west of Saint Petersburg, Russia. (See Figure 7.7)



Figure 7.7
Helsinki, Finland Location Map

Helsinki is the second northernmost capital in the world, located on the 60th latitude, just below Anchorage on the 61st. Yet, Helsinki's climate is mild in comparison, and there are four distinct seasons. The average temperature in Helsinki is 16° C in summer and -5° C in winter, daytime and nighttime temperatures combined. Daylight conditions vary dramatically: there are 6 hours of daylight (the sun stays above the horizon) in the heart of winter, and 19 at the peak

of summer, in addition to associated twilight. On Summer Solstice, the sun sets at 10.50 pm, and the summer sky never becomes completely dark.

Helsinki is part of the City Council of Helsinki administration. The 2015 population for Helsinki, per the City Council of Helsinki boundaries, was 626,305 (Official Statistics of Finland - OSF, 2016). Helsinki is the largest and most dense city in Finland. Helsinki is the third largest city in Scandinavia after Stockholm and Copenhagen. In the larger Baltic Region, which includes all countries that border the Baltic Sea, Helsinki ranks fourth, with the Latvian Capitol of Riga, containing 641,007 people (2015) occupying the third position.

The City of Helsinki's central area within municipal boundaries are 715.49 km² with a population of 626,305 individuals. However, the City of Helsinki's municipal boundaries include 501 km2 of water area in the Gulf of Finland. Thus, land-based area only of 213.75 km² result in a more realistic population density of 2,926.66/km2. This resulting population density is the densest in Finland (VÄESTÖTIETOJÄRJESTELMÄ , 2015)

Helsinki Urban Region

As mentioned, Helsinki is the largest and most dense city in Finland. It forms the core of the Helsinki Region, also called the Capital Region, and the Greater Helsinki Region. The Helsinki Region is located in the Uusimaa Region in southern Finland (See Figure 7.8).



Figure 7.8
Helsinki Urban Region Location Map
(Credit: Norman Einstein)

The Helsinki Region is defined as the four (4) municipalities of Helsinki, Vantaa, Espoo and Kauniainen and is considered an integrated urban region (MOE, 1997), also referred to as the Capital Region (Finnish: Pääkaupunkiseutu), essentially encompassing those municipalities that have a Finnish status as a 'City'. The Helsinki Region has a total population of 1,115,942 inhabitants (2015), land area of 770.26 km2 (City information and statistics, 2015) and a population density of 1,448.79/km². (See Table 7.2).

The Helsinki Region is part of the larger Greater Helsinki Region (Finnish: Helsingin seutu), sometimes referred to as the Helsinki Metropolitan Region. The Greater Helsinki region is the largest urbanised area in the country with 1,402,394 inhabitants (Helsingin+Seutu, 2014). Ten other municipalities are considered to be part of the Greater Helsinki Region and include Hyvinkää, Järvenpää, Kerava, Kirkkonummi, Nurmijärvi, Sipoo, Tuusula, Mäntsälä, Pornainen and Vihti.

Additionally, the cities of Porvoo, Lohja, and Riihimäki are often considered part of the Greater Helsinki Region in planning documents, bringing the total population to about 1,400,000.

As with most large urban regions, classification and terminology varies. The European Union identifies the very similar area (i.e. continuous urban area surrounding the City of Helsinki) as the Helsinki Metropolitan Area and the Helsinki Larger Urban Area (Eurostat 2014). Another notable physical designation utilised in spatial planning for the Helsinki region is Greater Helsinki. Though this region is difficult to spatially define, it generally includes those urbanised areas and city-regions physically attached to the City of Helsinki. When viewed comprehensively, these urbanised regions create a single, continuous urbanised area, or conurbation.

Though Greater Helsinki's physical designation is somewhat malleable and fluid, recent planning documents note Porvoo, Lohja, and Riihimäki as being 'commuter towns', and thus sometimes included in planning documents depending on context. This research shall refer to Greater Helsinki and the aforementioned designations as the HUR in order to correlate to that utilised in the Glasgow case study (i.e. GGUR).

As such, the HUR is the third largest urban region in Scandinavia after regions of Stockholm and Copenhagen. In the larger Baltic Region, which includes all countries that border the Baltic Sea, these rankings remain the same, with the Latvian Capitol, Riga, containing 1,089,767 people (Eurostat, 2014) placing fourth.

No agreeable definition or physical boundary exists for the Greater Helsinki Region. For the context of this research, the HUR, including the commuter municipalities, has a total population of 1,747,340 (2015) inhabitants, land area of 6,623 km2 and a population density of 264/km² (See Table 7.2). At almost 1.8 million people in population, the HUR encompasses almost 1/3 of Finland's total population (2015).

Helsinki was ranked first in European health and sanitation (2007) according to Mercer Human Resources and ranked second safest among personal safety and security (2007). The Economist Intelligence Unit's 2012 Livability

Survey ranked Helsinki 8th of all cities. In 2011, the Monocle Magazine in turn ranked Helsinki the most liveable city in the world in its Liveable Cities Index 2011.

Finland is consistently ranked high in quality of life and life satisfaction indices. Finland ranked 12th on the Organization for Economic Cooperation and Development's (OECD) Better Life Index (2013) where it ranked second in 2010. Finland also ranked 12th again on the Economist Intelligence Unit's quality-of-life index (2012) and 8th in its liveability survey. Finland is ranked as number four in the world for children's well-being (UNICEF, 2013). According to the UN World Happiness Report, Finland is among the three happiest nations in the world (http://www.ifhe.org, 2012). In August 2010, Newsweek declared that Finland is the best country in the world. They based their conclusion on five criteria: health, economic dynamism, education, political environment and quality of life. Additionally, the New Economics Foundation's (NEF) National Accounts of Well-being project profiled Finland as one of the highest in Europe (2011).

Municipality	**Area**	**Population** *(2015-06-30)*	**Population density**
Helsinki	213.75 km²	626,305	2,930.08/km²
Espoo	312.26 km²	267,906	857.96/km²
Vantaa	238.37 km²	212,473	891.36/km²
Kauniainen	5.88 km²	9,258	1,574.49/km²
Helsinki Region *(Capital Region)*	***770 km²***	***1,115,942***	***1,449/km²***
Hyvinkää	322.62 km²	46,512	144.17/km²
Mäntsälä	580.84 km²	20,649	35.55/km²
Pornainen	146.50 km²	5,156	35.19/km²
Järvenpää	37.55 km²	40,837	1,087.54/km²
Kerava	30.62 km²	35,362	1,154.87/km²
Kirkkonummi	366.10 km²	38,539	105.27/km²
Nurmijärvi	361.84 km²	41,880	115.74/km²
Sipoo	339.62 km²	19,235	56.64/km²
Tuusula	219.51 km²	38,462	175.22/km²
Vihti	522.06 km²	29,067	55.68/km²
Greater Helsinki *(Helsinki Metropolitan Region)*	***3,698 km²***	***1,431,641***	***387/km²***
Commuter towns (Porvoo, Lohja, and Riihimäki**)**	2,927.26 km²	315,699	107.85/km²
Helsinki Urban Region	***6,623 km²***	***1,747,340***	***264/km²***

Commuter Town
Porvoo - area = 2,139.19 sq km, population = 49,964, density = 76.32/km^2
Lohja - area = 441.19 sq km, population = 47,590, density = 136.2/km^2
Riihimaki - area = 125.56 sq km, population = 29,340, density = 242.44/km^2

Source: ("VÄESTÖTIETOJÄRJESTELMÄ REKISTERITILANNE 30.06.2015" (in Finnish and Swedish). Population Register Center of Finland. Retrieved 17 July 2015.)

Table 7.2
Helsinki Urban Region
Area, Population, and Population Density Statistics

Peri-Urban Conurbation

The HUR contains the following two (2) polycentric sub-centres within its conurbanation: Espoo (267,906 inhabitants, 2015) and Vantaa (212,473 inhabitants, 2015) (See Figure 7.9 and 7.10). Though Kauniainen is distinctly morphologically polycentric, is a small municipality with only 9,258 inhabitants and is often considered part of Espoo. ("VÄESTÖTIETOJÄRJESTELMÄ REKISTERITILANNE, 2015) These two polycentric sub-centres represent the first and third largest city-designated areas in Finland, respectively. Both Espoo and Vantaa are similar in empirical characteristics and considered the two most prominent sub-centres within the HUR. Both have similar population sizes, similar densities, and are approximately 22km from Helsinki's urban centre. The growth rate for both are similar as well over the last decade (Eurostat) (See Figure 7.11).

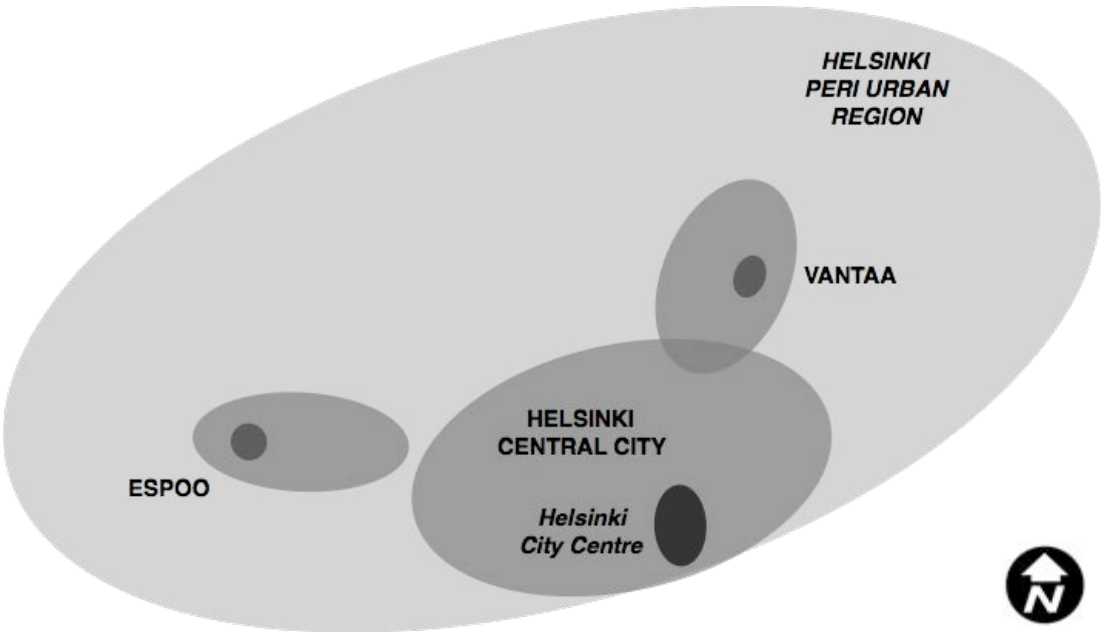


Figure 7.9
Helsinki Urban Region Polycentric Diagram
(Abstracted Physical Connectivity Field representing Morphological Polycentricity)

Grey areas indicate urban population density, lighter areas are less densely populated areas. No density metrics are known, this is a diagram only to show the morphological spatial relationship between the urban areas only.

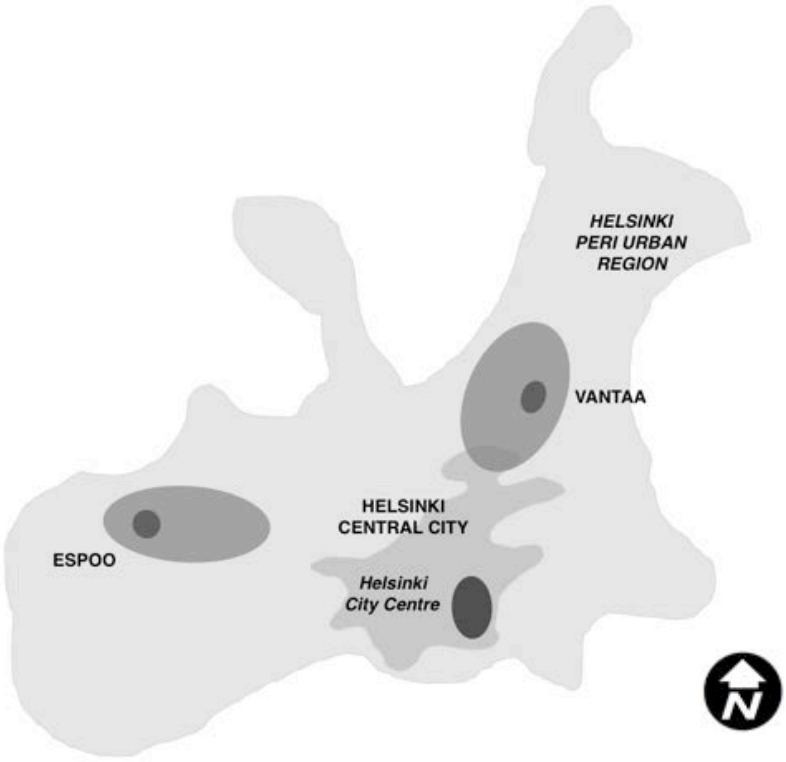


Figure 7.10
Helsinki Urban Region Conurbation Diagram
(Spatially Appropriate Physical Connectivity Field representing Morphological Polycentricity

Grey areas indicate urban population density, lighter areas are less densely populated areas. No density metrics are known, this is a diagram only to show the morphological spatial relationship between the urban areas only.

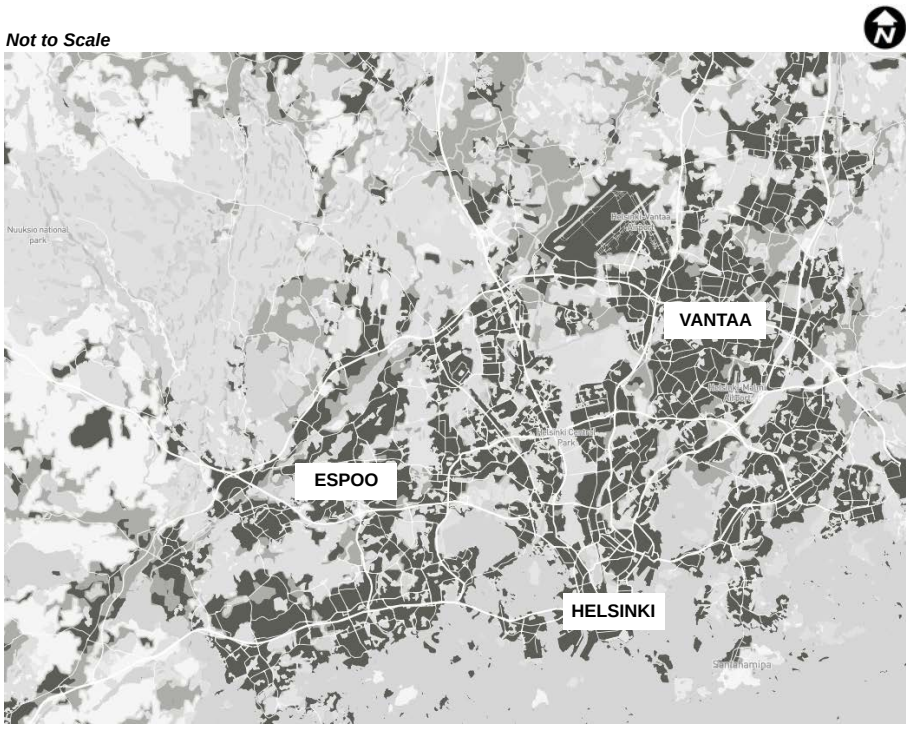


Figure 7.11
Helsinki Urban Region Conurbation

Grey areas indicate urban population density, lighter areas are less densely populated areas. No density metrics are known, this is a diagram only to show the morphological spatial relationship between the urban areas only.

This research selected Vantaa as the case study area (CA), specifically because it physically borders the urban centre, the City of Helsinki, and includes some significant water-based spatial typologies to match that within the GGUR and the Paisley CA.

7.2.3 Case Study Area Facts and Figures

Though both polycentric conurbations exist in different anthropological and biophysical contexts, effective comparison requires, to the best possible extent, shared characteristics. Both morphological and GS commonalities were required within and among the two CAs as well as the wider region's other polycentric sub-centres and PUAs:

- *physically inclusive of a small portion of urban centre (e.g. Glasgow City and City of Helsinki);*
- *physically inclusive of significant water-based typology (e.g. River Clyde and Gulf of Finland);*
- *physically inclusive of an airport typology;*
- *physically inclusive of a regional park typology;*
- *physically inclusive of the polycentric sub-centre core (Paisley and Vantaa).*

The Paisley, Scotland CA boundary is 79.293 km2 (79,289,503 sq m). This CA (See Figure 7.12 and 7.13) includes all municipal boundaries of Paisley and partial municipal areas of Glasgow.

The Vantaa, Finland CA boundary is 130.86 km2 (130,860,973 sq m). This CA (See Figure 7.14 and 7.15) includes all municipal boundaries of Vantaa and partial municipal areas of Helsinki.

A 10km CA extension (10km) was created to ensure contextual consistency among the various land uses, land covers, development pressures, GS connectivity, and spatial fragmentation. For Paisley, this area is 789.84 km2 (789,844,910 sq m) (See Figure 7.16). For Vantaa, this area is 974.58 km2 (974,577,371 sq m) (See Figure 7.17).

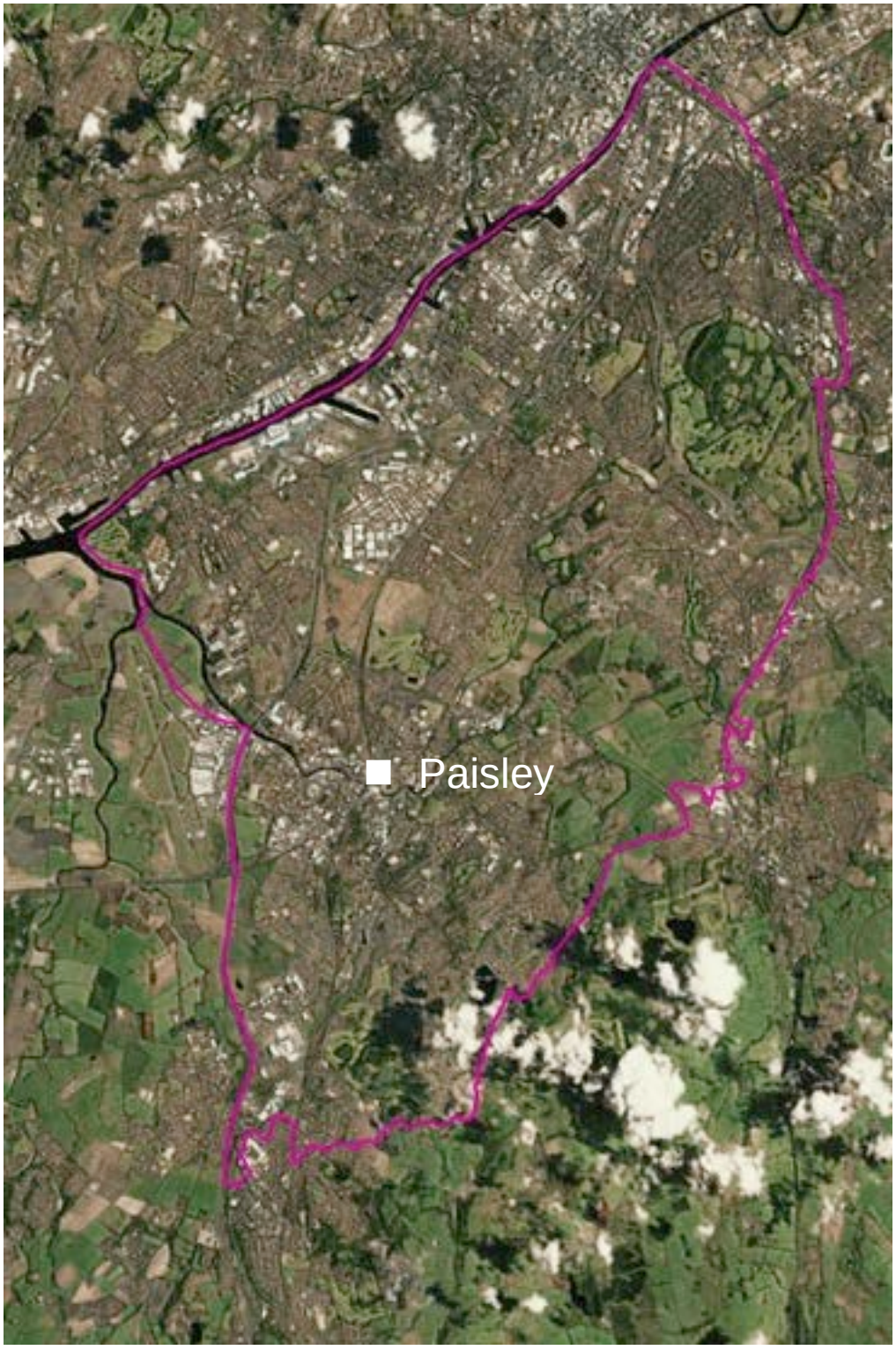


Figure 7.46
Paisley Case Study Area Shown in Purple Outline
79,289,503 sq m (79.293sq km)
Orthophoto Source: Google Earth, Digital Globe 2015



Figure 7.13
Paisley Case Study Area Shown in Black Outline– Land Cover Map
79,289,503 sq m (79.293sq km)
GIS Source: European Nature Information System, Land Cover Scotland 2014

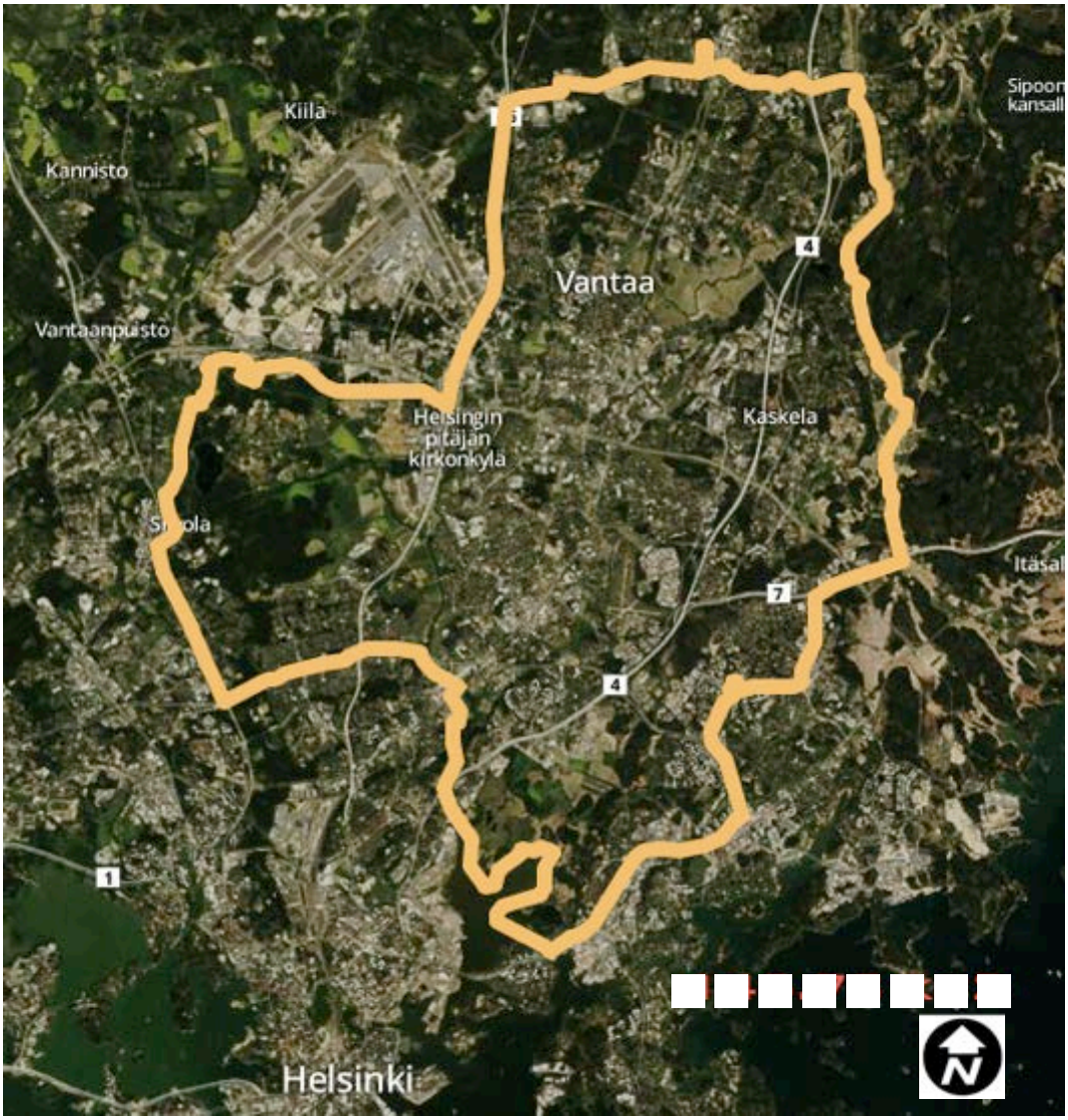


Figure 7.14
Vantaa Case Study Area shown in Yellow Outline
130.86 km2 (130,860,973 sq m)
Orthophoto Source: Google Earth, Digital Globe 2015

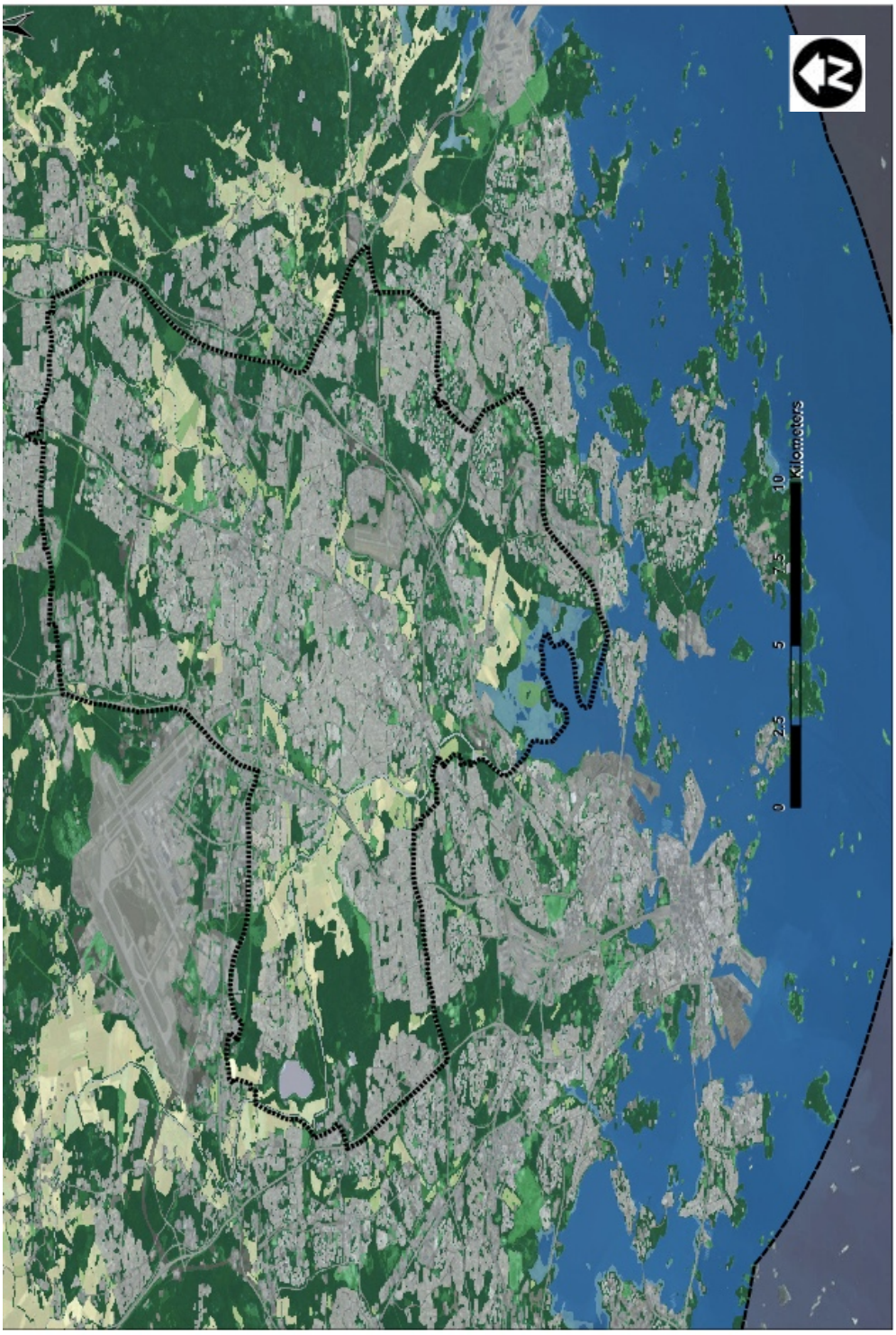


Figure 7.15
Vantaa Case Study Area Shown in Black Outline– Land Cover Map
130.86 km2 (130,860,973 sq m)
GIS Source: The European Environment Agency, CORINE Land Cover 2012

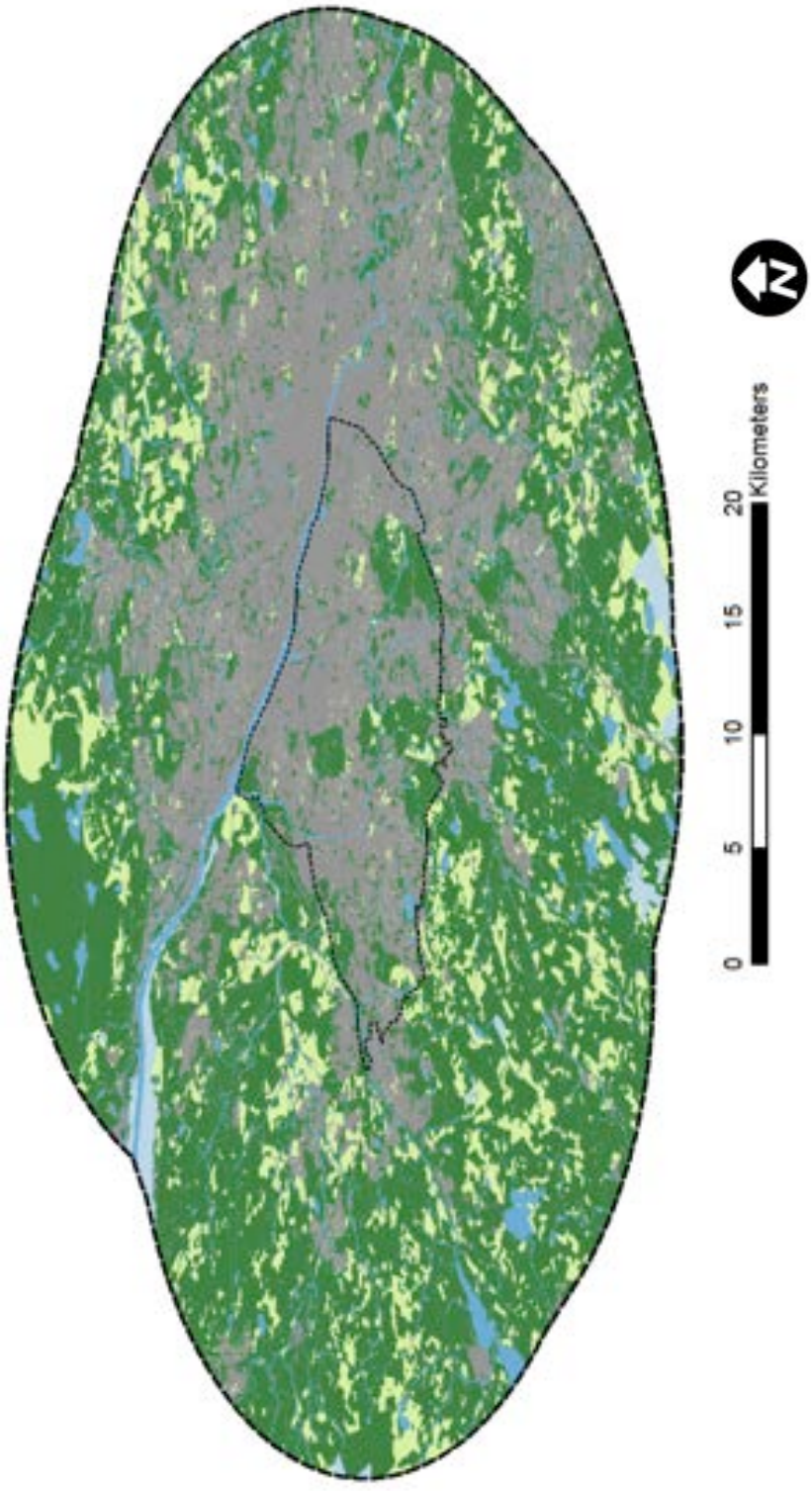


Figure 7.16
Paisley Case Study Area – 10km Extension
789,844,910 sq m (789.84 sq km)
GIS Source: European Nature Information System, Land Cover Scotland 2014

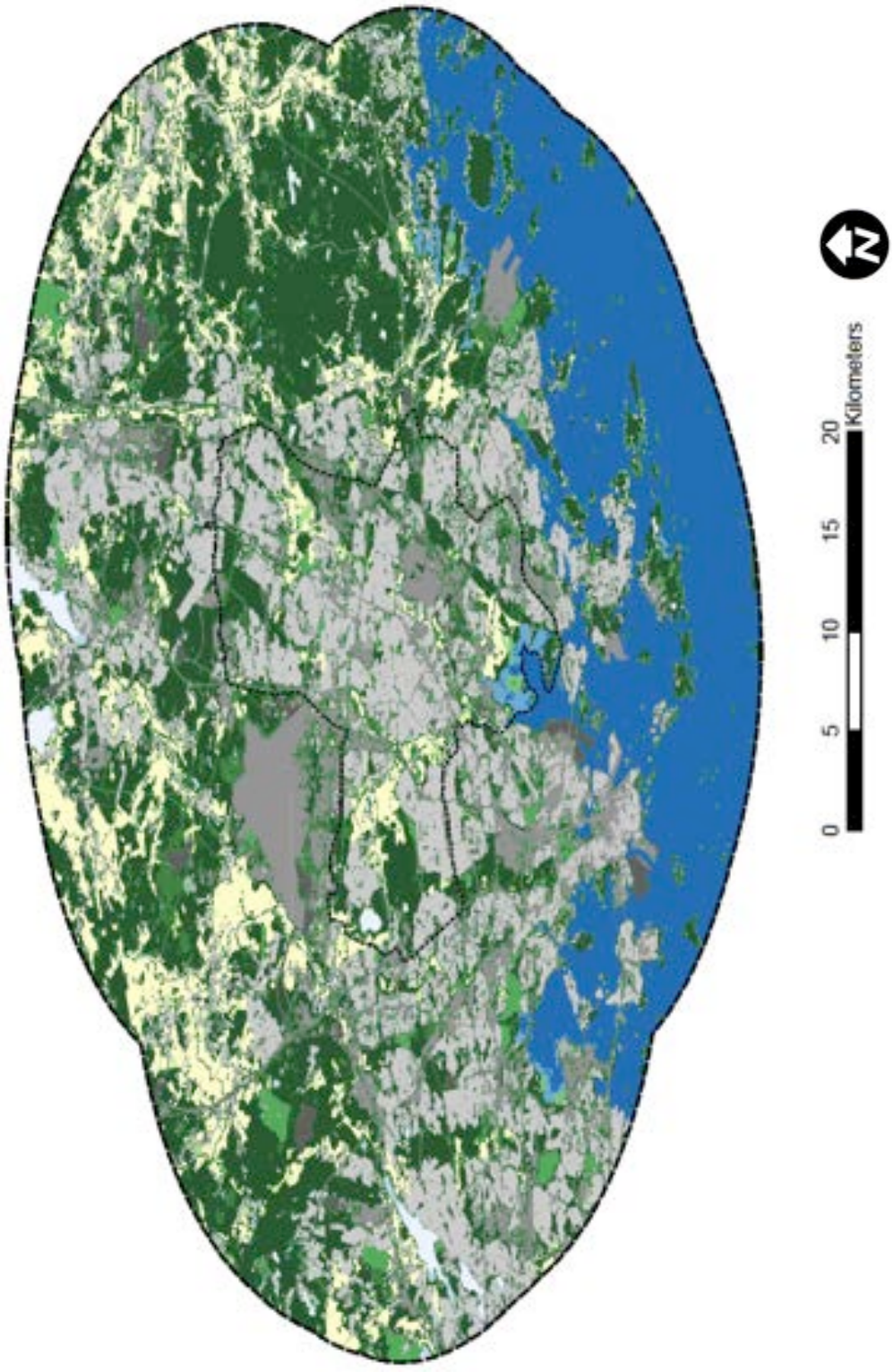


Figure 7.17
Vantaa Catchment Area – 10km Extension
974.58 km2 (974,577,371 sq m)
GIS Source: The European Environment Agency, CORINE Land Cover 2012

7.3 Research Strategy #1: Case Study Spatial Landscape Analysis

This research has focused on two specific physical characteristics common to contemporary European spatial development: polycentric urbanisation and landscape fragmentation (See Chapter 3). The selected two case study European urban regions are exemplary of these characteristics.

Within each urban region there are multiple sub-centres associated with each region's core city (i.e. Helsinki and Glasgow). These sub-centres are typically on the perimeter of the urban region, referred to as the PUA so that, overall, both city-centre and sub-centres have developed into a single conurbation.

Within the polycentric conurbation's PUAs there is currently undeveloped land, often referred to as open space, but which is in fact some type of green space or green structure (GS), often agricultural, grassland, forest or woodland. Yet these green structures can be very unique – they are not 'urban' and they are not 'rural' in character; they are a specific type 'peri-urban' green structure (PUGS). These GS exist between the polycentric sub-centres and other smaller cities within the larger regional conurbation – they are IntGS and GS 'in-between' the polycentric sub-centres and other city centres of urbanised zones, referred to previously in this thesis as PPUIGS.

The spatial context of each case study area was studied in order to build a comprehensive understanding of the current state and potential future state of the region's morphology and PPUIGS characteristics. Morphology is a term utilised in this section to refer to the landscape's structure, which is determined through its spatial forms and patterns. Thus, the term morphology refers to the CA's spatial form and spatial pattern, i.e. spatial structure. This morphological approach is common in landscape analysis (Lynch 1960; Lewis 1969; March and Steadman 1971).

7.3.1 Measuring Landscape Fragmentation

The field of landscape ecology has developed the most prominent landscape fragmentation metrics, including patch and edge metrics, connectivity and adjacency measures, cohesion, and diversity indices, among others (McGarigal and Marks, 1995; Jaeger, 2000; Opdam et al., 2003).

Landscape fragmentation is difficult to represent given the complexity of the dynamic landscape and relationships, but researchers and planners have developed multi-scaled and multi-method assessments to study and measure the dynamics of landscape change and landscape fragmentation through spatial morphological analysis (McGarigal and Marks, 1995; O'Neill et al., 1988; Dramstadt et al., 1998; Frohn, 1998; Lambin, 1999) including patterns and drivers of fragmentation. Most are systematic, deductive methods and focus on land cover and/or land use characteristics using a variety of tools and models as well as indicators (e.g. demographics, urban density). Two primary landscape measurement methodologies dominate the literature: visual analysis approaches and spatial metric approaches and are utilised herein.

Figure 7.18 provides an overview of the methodology and instruments applied to analyse the case study's morphological and landscape fragmentation characterstics. Academic and scientific literature has already determined that the PUAs in these two polycentric regions exist in a fragmented state (e.g. European Landscape Convention - ELC, EPSON 2013; EEA, 2011). Building on the specific regional polycentric criteria, the significant spatial characteristic within the selected case study regions required for this research's goal and objectives was landscape fragmentation as exhibited through their interstitial GS.

A series of multi-scalar and multi-method analyses were completed which qualitatively and quantitatively assessed landscape fragmentation and the spatial characteristics of the CA's GS. Two complementary techniques were utilised – a visual analysis (See Section 7.3.2) and a geospatial or GIS-based analysis (See Section 7.3.3).

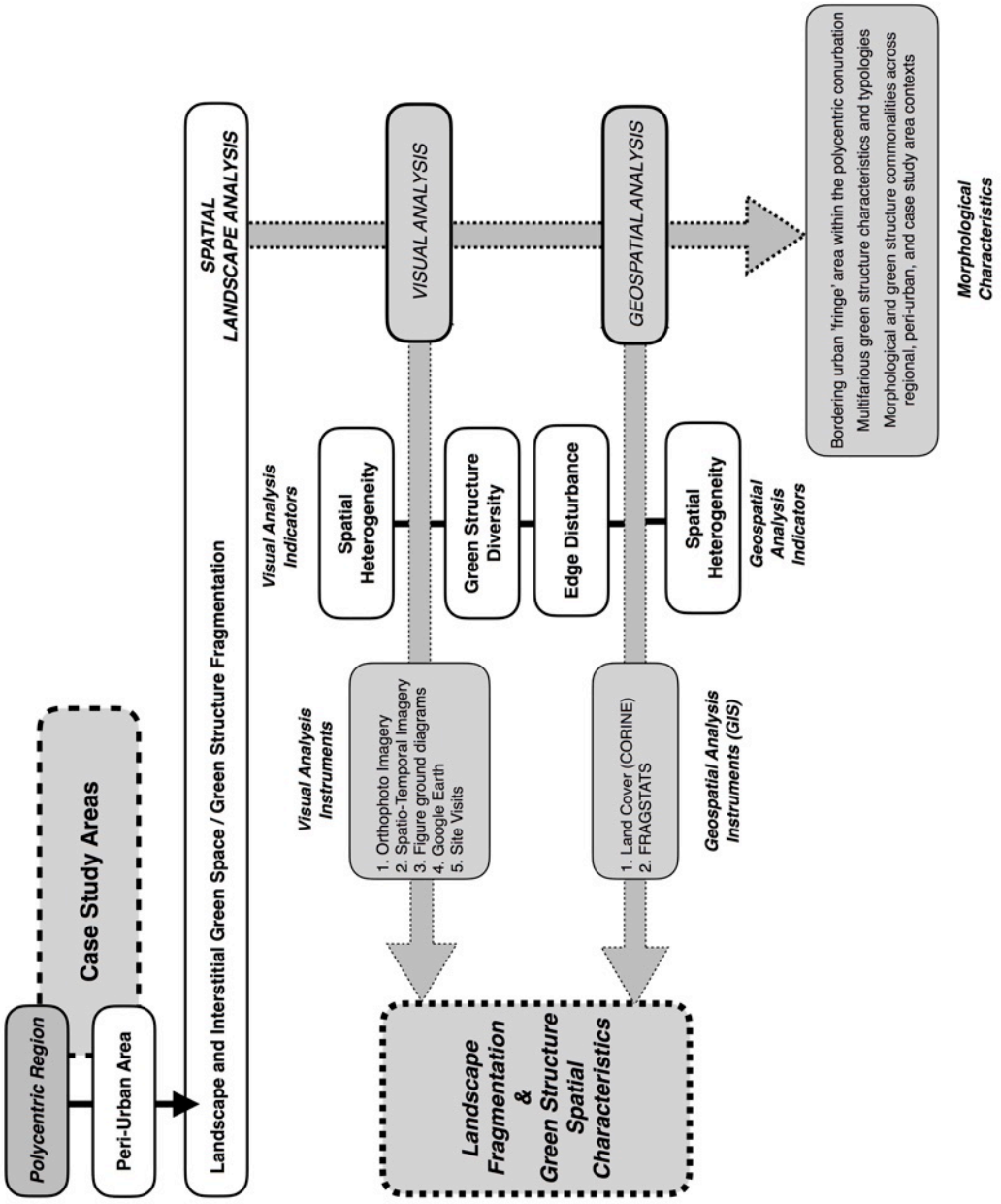


Figure 7.18
Case Study Area Methodological Framework for Spatial Landscape Analysis

The methodological framework to comprehensive analyse spatial heterogeneity and landscape fragmentation within each case study area to provide a well informed understanding of GS characteristics

7.3.2 Case Study Visual Analysis of Landscape Fragmentation and Green Structure Characteristics

There are many integrated anthropic and biophysical (Alberti 2005) landscape fragmentation indicators and methods that have been utilised in research to analyse and confirm landscape fragmentation in urban or peri-urban areas (e.g. Saunders et al., 1991; Taylor, 2000; Bogaert et al., 2005; Kupfer, 2006). Landscape fragmentation, especially as affected by the urbanisation process, is most easily recognised by its characteristics, Fragmentation theory, as discussed by Faring (1998) and Carvalho et al. (2009) states that the visual identification of landscape fragmentation is best achieved through characteristics of:

1. Diversity,
2. Heterogeneity,
3. Edge Effect.

These characteristics, together, serve as literature-supported proxies for identifying landscape fragmentation in a peri-urban context. These visual analysis indicators and qualities assessed the landscape's morphology and GS spatial characteristics in both structural and descriptive measures.

Spatial heterogeneity, GS diversity and edge effect or edge disturbance are straightforward measures of landscape and GS fragmentation. Both are simple to define and comprehend and can be readily analysed visually and spatially. These characteristics are easiest to determine in both interstitial and PUAs, as these landscapes exhibit neither 'urban' spatial characteristics (e.g. density) nor 'rural' spatial characteristics (e.g. open lands). As discussed in Chapter 3, PULs and their associated GS have both urban and rural spatial characteristics and are spatially distinct from other spatial forms along the urban-rural transect (e.g. Jongman, 2002; Alberti, 2005). An important aspect to assessing a landscape's fragmented state is perhaps best achieved when viewed in the context of the other landscapes within the region, here the urban centre and the rural hinterland.

These three morphological characteristics were selected for their specific relevance to not only landscape-based research but also fragmented landscape characteristics found within Europe's PURs (PLUREL, 2013; EPSON, 2013).

Visual Analysis Indicator #1 - Spatial Heterogeneity

As informed through the literature review, spatial heterogeneity is a standard characteristic of landscape fragmentation (e.g. Cushman & McGarigal, 2002). Spatial heterogeneity includes physical spaces of mixed concentrations at multiple size and shapes, and encompasses diverse land covers and/or land uses.

Visual Analysis Indicator #2 – Green Structure Diversity

Green structure diversity is an outcome of landscape fragmentation. This analysis required the identification of diversity in GS - their physical characteristics such as size, shape, edge conditions, composition and management. Additionally, this analysis required the identification of a diversity of GS types or typologies. This analysis assessed GS in their spatial diversity both vertically and horizontally.

Visual Analysis Indicator #3 – Edge Effect

Not only is edge disturbance a significant driver of landscape fragmentation and change within urbanising landscapes, it is herein viewed as an outcome or state of PUAs. Edge effect and edge disturbances indicate spatial heterogeneity and diversity.

Overall, these morphological characteristics, taken together, add to the comprehensive structural and descriptive analysis of the spatial arrangement or morphology of the PUR's landscape and their GS, to the best degree possible. This analysis, however, was but one piece in the data collection and analysis of the larger integrated perspective into the human-nature relationship within polycentric, peri-urban fragmented regions and their GS.

7.3.2.1 Landscape Fragmentation and Green Structure Characteristics Visual Analysis Instruments

This visual analysis was primarily a qualitative assessment conducted by the researcher, who is an expert in the field, but based on the strong theoretical and conceptual basis for this analysis. The language required to analyse and assess the morphology of landscapes comprehensively is abstract yet concrete, and strives to be fundamentally value-free in description. This analytical approach removed perception and interpretation in its language and allowed for more direct knowledge sharing in its analytical outcomes.

This visual analysis was both a remote-sensed (i.e. Google Maps, orthophotos, etc.) and on-site procedure. Research has supported utilising remote sensing in concert with other sources of data to analyse land use change and landscape composition, particularly urbanisation and landscape fragmentation (Acevedo et al., 1996; Clarke et al., 1996; and Wu, 1998).

Four visual analytical instruments were operationalized to analyse spatial heterogeneity, green structure diversity and edge effects within the two selected PolyPUR's CAs.

Visual Analysis Instruments

1. Orthophoto Imagery;

2. Figure-Ground Diagrams;

3. Spatio-Temporal Imagery;

4. Site Visits.

7.3.3 Case Study Geospatial Analysis of Landscape Fragmentation and Green Structure Characteristics

The geospatial analysis was primarily a quantitative assessment. GIS (ArcGIS 10.2.1) was selected as the primary geospatial analysis tool. GIS metadata per the EEA standard of CORINE land cover was collected for the CAs. CORINE stands for 'coordination of information on the environment' and was initiated within Europe in 1985 and its database currently managed by the EEA.

7.3.3.1 Landscape Fragmentation and Green Structure Characteristics Geospatial Analysis Instruments

Two geospatial analytical instruments utilising ArcGIS were operationalised to confirm and assess spatial heterogeneity, green structure diversity and edge effects within the two CAs:

Geospatial Analysis Instruments

1. CORINE Land Cover Analysis;

2. FRAGSTATS Spatial Analysis Tool.

Although the CORINE data and land cover nomenclature varied somewhat in each case study region, specifically in the Level IV and Level III Classes, the

Level II Classes were noted to be mostly similar across each CA. Thus, Level II and Level I CORINE Classification (2012) were the Class Levels analysed in this research.

FRAGSTATS is a public domain statistical analysis program focussing on spatial metrics and was developed in the mid-1990s and has been continuously improved since (McGarigal et al., 2002). FRAGSTATS is considered the most comprehensive, commonly used, and user-friendly program available when analysing landscape fragmentation through GIS and was selected as this research's landscape fragmentation tool. This research utilised Version 4.2 and was embedded into ArcGIS 10.2 in order to complete the analysis. Appendix 3 provides additional information regarding the specific procedure for converting and coding the data for the FRAGSTATS application, the landscape metric parameters selected, post-hoc data adjustments, and subsequent applied metrics within the final analysis.

Spatial pattern analysis provides a methodology to describe the distribution of spatial data within the landscape, primarily digital based data, through software such as Geographic Information Systems (GIS). Spatial data is a standardised requisite within current governmental and landscape planning constructs, comprising *"observations of some phenomenon that possess a spatial reference"* (Fotheringham et al., 2000, p.15).

FRAGSTATS analyses landscape pattern based on specific characteristics and serves to better understand the relationship between spatial patterns and GS and overall landscape composition. This study operationalised the FRAGSTATS analysis through four overarching spatial fragmentation characteristics shown to impact the GS-HWB relationship and both ecological – HWB performance (See Table 7.3).

Size
Shape
Proximity
Edge

Table 7.3
GS and Landscape Fragmentation Characteristics reflected within FRAGSTATS

This research selected, as supported by literature (e.g. Li and Reynolds, 1993; See Appendix 3) and subjectively, based on knowledge of polycentric PULs and their PPUIGS currently undergoing fragmentation, the following set of landscape fragmentation metrics to measure as the optimal landscape fragmentation analysis index (See Table 7.4).

Area/Density/Edge Metrics;
Contrast Metrics;
Diversity Metrics;
Shape Metrics;
Contagion/Interspersion Metrics;
Core Area Metrics;
Isolation/Proximity Metrics;
Connectivity Metrics.

Table 7.4
Index of FRAGSTATS Landscape Fragmentation Analysis Metrics

Each of the landscape fragmentation metrics selected have significant biophysical and ecological integrity relevance, which literature is complete with, however literature is not comprehensive with landscape fragmentation metrics and their anthropological relevance, particularly HWB.

As a group, the index captures the morphological change found within the current state of the landscape undergoing fragmentation, and, importantly, all the significant indicators of fragmented PPUIGS.

Thus, in order to comprehensively analyse, nineteen individual metrics were calculated to quantify the landscape pattern of both the CA and the 10km (See Table 7.5). A full description of each metric and can be found in McGarigal and Marks, 1995. As shown, the metrics are not grouped into patch, class, and landscape indices but rather the GS characteristic in which they quantify. Table 7.5 shows the detailed table for each FRAGSTATS spatial metric with both the GS Characteristics and Attribute it analyses as well as the specific measure or tool applied including their respective levels. These indices and each of their associated measures provide an aggregate of some basic or exemplary fragmentation characteristic for each metric.

FRAGSTAT METRIC	GS Characteristic	GS Attribute	Measure Tool	Mesaure Tool Name	Measure Tool Range
AREA/DENSITY/EDGE METRICS	Size	Area, Typology	CA	Class Area	AREA > 0, without limit.
AREA/DENSITY/EDGE METRICS	Size	Area	NP	Number of Patches	NP ≥ 0 ,without limit
AREA/DENSITY/EDGE METRICS	Size	Largest	LPI	Largest Patch Index	0 < LPI <= 100
AREA/DENSITY/EDGE METRICS	Size	Density, Typology	PLAND	Percentage of Land	%, 0 < PLAND <= 100
AREA/DENSITY/EDGE METRICS	Size	Density	PD	Patch Density	PD > 0, constrained by cell size.
AREA/DENSITY/EDGE METRICS	Edge	Total Edge	TE	Total Edge	TE ≥ 0 ,without limit
AREA/DENSITY/EDGE METRICS	Edge	Edge Density	ED	Edge Density	ED = 0, without limit
AREA/DENSITY/EDGE METRICS	Shape	Regulation, Typology	LSI	Landscape Shape Index	LSI ≥ 1, without limit.
CONTRAST METRICS	Edge	Edge Density	CWED	Contrast-Weighted Edge Density	CWED >= 0, without limit.
CONTRAST METRICS	Edge	Edge Density	TECI	Total Edge Contrast Index	0 ≤ TECI ≤ 100
AREA/DENSITY/EDGE METRICS	Size	Area	TCA	Total Core Area	TCA ≥, without limit
AREA/DENSITY/EDGE METRICS	Size	Area	CPLAND	Core Area Percentage of Landscape	0 <= CPLAND < 100
AREA/DENSITY/EDGE METRICS	Size	Area	NDCA	Number of Disjunct Core Areas	NDCA >= 0, without limit.
AREA/DENSITY/EDGE METRICS	Size	Area, Density	DCAD	Disjunct Core Area Density	DCAD ≥ 0, without limit
CONTAGION/INTERSPERSION	Shape	Complexity & Diversity	CLUMPY	Clumpiness Index	-1 ≤ CLUMPY ≤ 1
CONTAGION/INTERSPERSION	Proximity	Isolation & Connectivity	PLADJ	Percentage of Like Adjancies	0 ≤ PLADJ ≤ 100
CONTAGION/INTERSPERSION	Proximity	Isolation & Connectivity	IJI	Interspersion Juxtaposition Index	0 < IJI ≤ 100
CONNECTIVITY METRICS	Proximity	Isolation & Connectivity	CONNECT	Connectance Index	0 ≤ CONNECT ≤ 100
CONNECTIVITY METRICS	Proximity	Isolation & Connectivity	COHESION	Patch Cohesion Index	None
BINARY ONLY					
CONTAGION/INTERSPERSION	Proximity	Isolation & Connectivity	CONTAG	Contagion	0 < CONTAG <= 100
AREA/DENSITY/EDGE METRICS	Size	Area, Density	TA	Total Area	TOTAL AREA > 0, without limit.
CONTAGION/INTERSPERSION	Proximity	Coherence	DIVISION	Landscape Division Index	0 ≤ DIVISION < 1
DIVERSITY METRICS	Shape	Complexity & Diversity	PR	Patch Richness	PR ≥ 1, without limit
DIVERSITY METRICS	Size	Density	PRD	Patch Richness Density	PRD > 0, without limit
DIVERSITY METRICS	Size	Density	RPR	Relative Patch Richness	0 < RPR ≤ 100
DIVERSITY METRICS	Shape	Complexity and Diversity	SHDI	Shannon's Diversity Index	SHDI >= 0, without limit
DIVERSITY METRICS	Shape	Complexity and Diversity	SIDI	Simpson's Diversity Index	0 ≤ SIDI < 1
DIVERSITY METRICS	Shape	Complexity and Diversity	MSIDI	Modified Simpson's Diversity Index	MSIDI >= 0, without limit
DIVERSITY METRICS	Shape	Complexity and Diversity	SHEI	Shannon's Eveness Index	0 ≤ SHEI ≤ 1
DIVERSITY METRICS	Shape	Complexity and Diversity	SIEI	Simpson's Eveness Index	0 ≤ SIEI ≤ 1
DIVERSITY METRICS	Shape	Complexity and Diversity	MSIEI	Modified Simpson's Evenness Index	0 ≤ MSIEI ≤ 1

INDICES					
AREA/DENSITY/EDGE METRICS	Size	Area	**AREA - PATCH AREA**		AREA >0, without limit.
			AREA_MN	MEAN	
			AREA_AM	AREA WEIGHTED MEAN	
			AREA_MD	MEDIAN	
			AREA_RA	RANGE	
			AREA_SD	STANDARD DEVIATION	
			AREA_CV	COEFF OF VARIATION	
SHAPE METRICS	Size	Complexity and Diversity	**SHAPE INDEX**		SHAPE > 1, without limit.
			SHAPE_MN	MEAN	
			SHAPE_AM	AREA WEIGHTED MEAN	
			SHAPE_MD	MEDIAN	
			SHAPE_RA	RANGE	
			SHAPE_SD	STANDARD DEVIATION	
			SHAPE_CV	COEFF OF VARIATION	
SHAPE METRICS	Shape	Complexity and Diversity	**FRACTAL DIMENSION INDEX**		1 <= FRAC <= 2
			FRAC_MN	MEAN	
			FRAC_AM	AREA WEIGHTED MEAN	
			FRAC_MD	MEDIAN	
			FRAC_RA	RANGE	
			FRAC_SD	STANDARD DEVIATION	
			FRAC_CV	COEFF OF VARIATION	
SHAPE METRICS	Shape	Complexity and Diversity	**PERIMETER AREA RATIO**		PARA > 0, without limit.
			PARA_MN	MEAN	
			PARA_AM	AREA WEIGHTED MEAN	
			PARA_MD	MEDIAN	
			PARA_RA	RANGE	
			PARA_SD	STANDARD DEVIATION	
			PARA_CV	COEFF OF VARIATION	
SHAPE METRICS	Proximity	Coherence	**CONTIGUITY INDEX**		0 <= CONTIG <= 1
			CONTIG_MN	MEAN	
			CONTIG_AM	AREA WEIGHTED MEAN	
			CONTIG_MD	MEDIAN	
			CONTIG_RA	RANGE	
			CONTIG_SD	STANDARD DEVIATION	
			CONTIG_CV	COEFF OF VARIATION	

AREA/DENSITY/EDGE METRICS	Size	Area	**PATCH CORE AREA INDEX**		CORE >= 0, without limit.
			CORE_MN	MEAN	
			CORE_AM	AREA WEIGHTED MEAN	
			CORE_MD	MEDIAN	
			CORE_RA	RANGE	
			CORE_SD	STANDARD DEVIATION	
			CORE_CV	COEFF OF VARIATION	
ISOLATION/PROXIMITY METRICS	Proximity	Isolation & Connectivity	**PROXIMITY INDEX**		PROX > 0.
			PROX_MN	MEAN	
			PROX_AM	AREA WEIGHTED MEAN	
			PROX_MD	MEDIAN	
			PROX_RA	RANGE	
			PROX_SD	STANDARD DEVIATION	
			PROX_CV	COEFF OF VARIATION	
ISOLATION/PROXIMITY METRICS	Proximity	Isolation & Connectivity	**SIMILARITY INDEX**		SIMI >= 0
		Typology	SIMI_MN	MEAN	
			SIMI_AM	AREA WEIGHTED MEAN	
			SIMI_MD	MEDIAN	
			SIMI_RA	RANGE	
			SIMI_SD	STANDARD DEVIATION	
			SIMI_CV	COEFF OF VARIATION	
ISOLATION/PROXIMITY METRICS	Proximity	Nearest Neighbor	**EUCLIDEAN NEAREST NEIGHBOUR**		ENN > 0, without limit
		Isolation & Connectivity	ENN_MN	MEAN	
			ENN_AM	AREA WEIGHTED MEAN	
			ENN_MD	MEDIAN	
			ENN_RA	RANGE	
			ENN_SD	STANDARD DEVIATION	
			ENN_CV	COEFF OF VARIATION	
CONTRAST METRICS	Edge	Edge Density	**EDGE CONTRAST**		0 <= ECON <= 100
		Diversity	ECON_MN	MEAN	
			ECON_AM	AREA WEIGHTED MEAN	
			ECON_MD	MEDIAN	
			ECON_RA	RANGE	
			ECON_SD	STANDARD DEVIATION	
			ECON_CV	COEFF OF VARIATION	

Note: The extended terms _MN, _AM, _MD, _RA, _SD, _CV mean 'mean', 'area-weighted mean', 'median', 'range', 'standard deviation', and 'coefficient of variation', respectively.

Table 7.5
FRAGSTAT Landscape Analysis Metrics and Associated GS Characteristics and Attributes

Landscape metrics can be calculated for different scales including individual patch, class (aggregation of same type of patches) and overall landscape. This research's application of FRAGSTATS utilised a hierarchy of level metrics: landscape, class and patch. These concepts were discussed in Chapter 2. Figure 7.19 illustrates the nineteen metrics and metric indices applied during the FRAGSTATS analysis but organised through the four primary GS and landscape fragmentation characteristics within Table 7.3.

Size	**Area - Density - Largest**
	Patch Core Area Index (CORE)
	Area Index (AREA)
	Total Area (TA)
	Total (Class) Area (CA)
	Number of Patches (NP)
	Largest Patch Index (LPI)
	Percentage of Landscape (PLAND)
	Patch Density (PD)
	Total Core Area (TCA)
	Core Area Percentage of Landscape (CPLAND)
	Number of Disjunct Core Areas (NDCA)
	Disjunct Core Area Density (DCAD)
Shape	**Regulation - Complexity & Diversity - Typology**
	Perimeter Area Ratio Index (PARA)
	Fractal Dimension Index (FRAC)
	Shape Index (SHAPE)
	Patch Richness (PR)
	Patch Richness Density (PRD)
	Relative Patch Richness (RPR)
	Shannon's Diversity Index (SHDI)
	Simpson's Diversity Index (SIDI)
	Shannon's Evenness Index (SIEI)
	Modified Shannon's Evenness Index (MSIEI)
	Modified Simpson's Diversity Index (MSIDI)
	Simpson's Evenness Index (SHEI)
	Modified Simpson's Evenness Index (MSHEI)
Proximity	**Nearest Neighbour - Isolation & Connectivity**
	Similarity Index (SIMI)
	Proximity Index (PROX)
	Contiguity Index (CONTIG)
	Patch Cohesion Index (COHESION)
	Connectance Index (CONNECT)
	Landscape Division Index (DIVISION)
	Clumpiness Index (CLUMPY)

	Interspersion & Juxtaposition Index (IJI)
	Percentage of Like Adjacencies (PLADJ)
	Contagion (CONT)
	Euclidean Nearest Neighbor Index (ENN)
	Nearest Neighbour (NN)
Edge	**Total Edge - Longest Edge - Edge Density**
	Edge Contrast Index (ECON)
	Total Edge (TE)
	Edge Density (ED)
	Contrast-Weighted Edge Density (CWED)
	Patch Perimeter (PERIM)
	Total Edge Contrast Index (TECI)

Figure 7.19
FRAGSTATS Applied GS and Landscape Fragmentation Metrics

The scale or physical boundaries for these analyses are at the community scale and sub-regional scale (i.e. CA and CA 10km Extension – See Figures 7.12 thru 7.17). The FRAGSTATS analysis operationalised three separate analyses for each of these two spatial contexts for each case study region. These analyses were Binary, Class Level I, and Class Level II completed at Landscape Levels and Class or Patch Levels. This procedure provided landscape fragmentation metrics at multiple scales, each generating a different contextual aspect of the same phenomena – fragmentation. Although each indicator within the index provides individual metrics reflecting landscape fragmentation, it is when they are all taken together that they serve as an accurate measure of fragmentation, with each metric capturing a different yet interrelated structural aspect of landscape fragmentation.

7.4 Research Strategy #2: Case Study Socio-Cultural Landscape Analysis

The socio cultural landscape analysis was an important component of this research, providing causual insight into the human nature relationship, specifically, what kinds and what types of people use what types and what kinds of PPUIGS for what kinds of HWB benefits.

The socio-cultural landscape analysis research instruments utilised in this research were a: 1) survey questionnaire (SQ) and 2) the collection of socio-economic data from publicly available sources, considered primary and secondary

data, respectively. The CAs determined the spatial context for this data collection. The SQ provided both qualitative and quantitative data including specific socio-demographic information of the survey participants and the geospatial data of specific GS with those associated HWB benefits afforded to the SQ participants.

7.4.1 Case Study Socio-Cultural Landscape Analysis Instrument #1 – Survey Questionnaire

7.4.2 Survey Questionnaire Introduction

There is an increasing need for a contextualised and transactional research approach, in which the focus of the study is directed toward a real-life event and embedded in a locally meaningful context (Gobster et al., 2007). Contemporary spatial landscapes are defined thorough prior human interaction, thus a methodology that analyses that relationship is appropriate.

This research focuses on the tangible and measurable aspects of the human-nature relationship operationalised through affordance theory within a SQ format (vs. the intangible - e.g. a state of mind such as personal achievement). The SQ was designed to explore the relationship between GS and HWB: firstly, HWB as compared to demographic factors and, secondly, HWB in relation to current interactions and use of GS specific to its eco-spatial characteristics.

Questionnaires are an efficient means to gather data and often provide *"useful"* quantitative data (Zeisel, 2006, p. 257). Questionnaires are an effective research data collection methodology, particularly in developing an approach for answering the research's hypothesis within the theoretical framework of Affordance Theory, and for measuring and analysing the human-nature relationship (Neuman, 2000) through interaction. The survey questionnaire was developed after a thorough literature review.

The survey's data collection was operationalised through an on-line, interactive, geo-location based SQ and accrued both qualitative and quantitative data simultaneously, such as socio-demographic information, GS use interactions, and the GS physical locations for those interactions (i.e. geocoded and map-based).

Unlike traditional empirical data collection and sampling captured exclusively through a survey, this research's SQ was digitally map-based (i.e. internet based) (See Figure 7.20) and focused on collecting biophysical-based, geospatial data of specific GS simultaneously with human-based socio-cultural data such as certain demographics and, importantly, how this GS was interacted with to provide a HWB benefit.

This research employed a new public participatory GIS (PPGIS) data collection tool (e.g. Craig et al. 2002) called 'soft' GIS' (Kahila and Kyttä, 2006). SoftGIS is a web-based, interactive tool that allows participants to map and evaluate their interaction or experience with that space. In this research, survey participants were able to provide specific locations of GS they visit and interact with, followed by descriptive attributes of what HWB benefit(s) they receive from that interaction. In this regards the transactional perspective found within Affordance Theory could be documented. Thus Hard-Data (the GIS, geospatioal-based locations of the GS) is collected concurrently with Soft-Data (the subjective qualities and affordance-based benefits of the GS). This is described in detail later in this section.

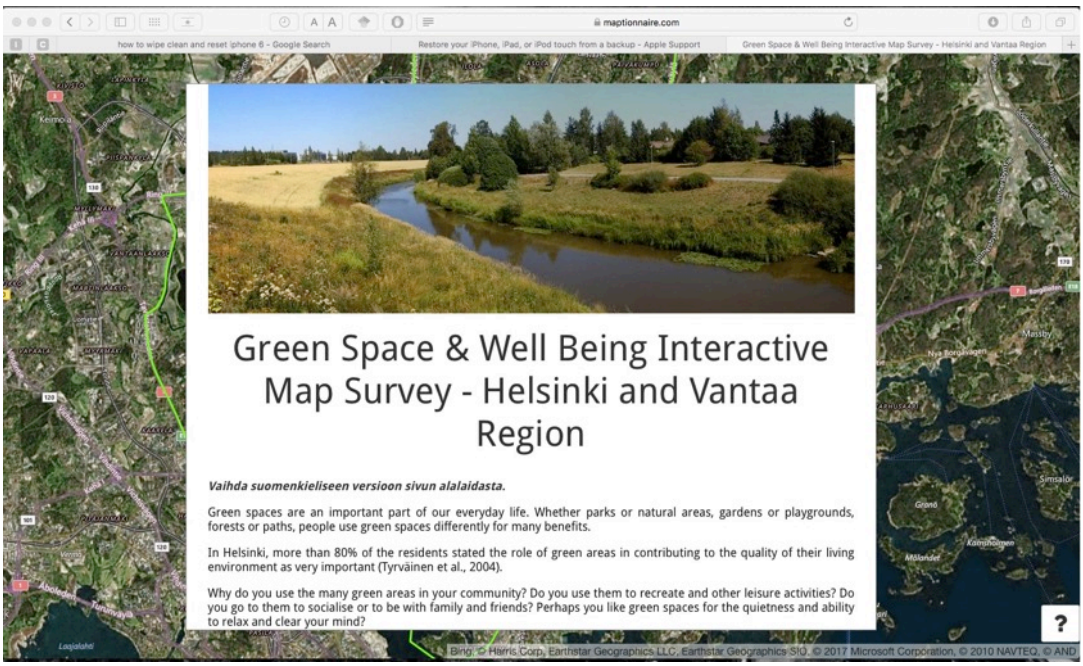


Figure 7.20
Web-Based (Digital) SQ Interface

7.4.3 Survey Questionnaire Preparation and Development

Appendix 5 provides a thorough description and explanation of the survey questionnaire's preparation and development including confidentiality and anonymity statements, University ethical approval, the languages utilised, the layout and graphic organisation, incentivation, anonymity, and opt-outs. This appendix also includes an overview of the SQ's review, pilot test and feedback prior to operationalisation.

7.4.4 Survey Questionnaire Delivery Method

The SQ was digital; it was an on-line, web-based, interactive data collection tool. A subscription or License Fee to Mapita, Inc. was purchased in 2014 to facilitate the SQ delivery and data collection. Mapita, Inc., located in Helsinki, Finland, is the only distributor of SoftGIS. An important methodology of this research was to distribute an on-line survey questionnaire through digital-means or an internet-based approach. This could then be circulated and shared electronically.

7.4.5 Survey Questionnaire Distribution and Participant Selection

The case studies specific CAs determined the geographic locations to collect the socio-cultural landscape data. The SQ was distributed through three primary methods: direct email, Facebook page, and on-site solicitation (See Figure 7.21).

The limited budget and timeframe of this student-led, PhD based research project meant no paper versions of the questionnaire were distributed. This includes no door-to-door solicitation, no postal delivery and responses, and no SQ's available for pick-up/drop-off.

1. Direct Email Distribution

Council Members

Paisley CA: City Councils of Renfrewshire, East Renfrewshire, and Glasgow
Vantaa CA: Helsinki-Uusimaa Regional Council, City Councils of Helsinki and Vantaa (kaupunginvaltuusto, VANTAA Metsähallitus).

Governmental and Municipal Employees (e.g. Directors, Planners)

Paisley CA

Council Departments – *Public Health, Forestry, Landscape Architecture/Planning, Community Health, Sport Hubs, etc.);*

Government agencies *(e.g. SHS, CRESH, SNH, Forestry Commission, etc.);*

Various NGO's *(e.g. GCV, Green Networks, Environmental Trusts, etc.)*

University Research Groups

Vantaa CA

City Departments *(Forestry, Planning, Sports Services, Environmental Policy, Landscape Architecture, Centre for Environmental Affairs, etc.);*

Government agencies *(e.g. Parks and Wildlife, Forestry Management, etc.);*

Various NGO's *(e.g. SYKE, GreenMap, etc.);*

University Research Groups.

Community Groups (e.g. Hiking, Sports, Environmental, etc.)

Figure 7.21
Survey Questionnaire Email Distribition Contacts

The direct Email distribution included a brief introduction letter describing the purpose and value of completing and sharing the SQ including a link to the SQ itself. Appendix 6 provides a discussion of the SQ email distribution strategy including sample introduction letters and a review of the distribution results.

2. Community Facebook page distribution

The benefits of a community Facebook page was its ease of sharing and wide distribution potential. Each CA had a separate Facebook page created with the Vantaa including a Finnish transaltion page. Detailed specifics for these pages distribution and development are found within Appendix 7. The purpose of the facebook pages was to provide a link to the SQ and utilised the same imagery and text found within the SQ.

By creating a Facebook page, it could then be easily shared and among users. It was strategically shared and posted on other Facebook pages within the Region(s), including a variety of public and private entities such as councils, parks, societies, gyms, community centres, churches and other interest groups.

3. On-site solicitation

An on-site SQ was provided at certain locations within the CAs and was an on-site, digital-based method (i.e. face to face while completing SQ). A small table and chairs and a computer was provided for respondents to complete the SQ. No paper versions of the questionnaire were provided.

In order to not exclude any participants who did not have access to the internet, emails, or Facebook page postings, flyers were provided within the regional community centre's noting SQ purpose, locations, and times. The following on-site SQ locations were provided:

Paisley, Scotland
Wednesday October 8, 2014, 10 - 3 pm
Renfrew Leisure Centre
Paisley Road
Renfrew, Scotland
PA4 8LJ
Wednesday October 15, 2014, 10 - 3 pm
Lagoon Leisure Centre
11 Christie Street
Paisley, Scotland, PA1 1NB

Vantaa, Finland
Wednesday November 15, 2014, 10 - 3 pm
Malmitalo Cultural Centre
Ala-Malmin tori 1
00700 Helsinki, Finland
Thursday November 16, 2014, 10 - 3 pm
Liikuntamylly Recreation Centre
Myllypurontie 1
00920 Helsinki, Finland

Figure 7.22
Survey Questionnaire Drop-In Details

The on-line SQ was operationalised on the following dates (2014-2015):

Questionnaire Activated	***Questionnaire Deactivated***	***Total Days***
Paisley, Scotland		
October 4, 2014	*November 14, 2014*	*42 days*
Vantaa, Finland		
November 12, 2014	*January 4, 2015*	*54 days*

Figure 7.23
Survey Questionnaire Activation Periods

The SQ was intended to be active for a two-week period. However, due to the distinct lack of responses for the Paisley, Scotland CA, this was extended 6 weeks or 42 days. Vantaa, Finland SQ had initial goals for a two-week activation period. However, after 6 weeks in order to match the Paisley, Scotland data collection period, the response rate was not near or equal to Paisley's final response count. Additionally, this SQ was active during the Christmas and New Years holiday time that could have caused a lower number of responses. Thus, another additional 2 weeks were provided allowing for a total of 54 days or nearly 8 weeks that the Vantaa, Finland SQ was active.

The SQ distribution was non-discriminatory and systematic. On-line research provided the list of contacts for both emails and Facebook. No follow up phone calls were made, repeated emails were sent to unresponsive user/groups, and email recipients could contact me if needed.

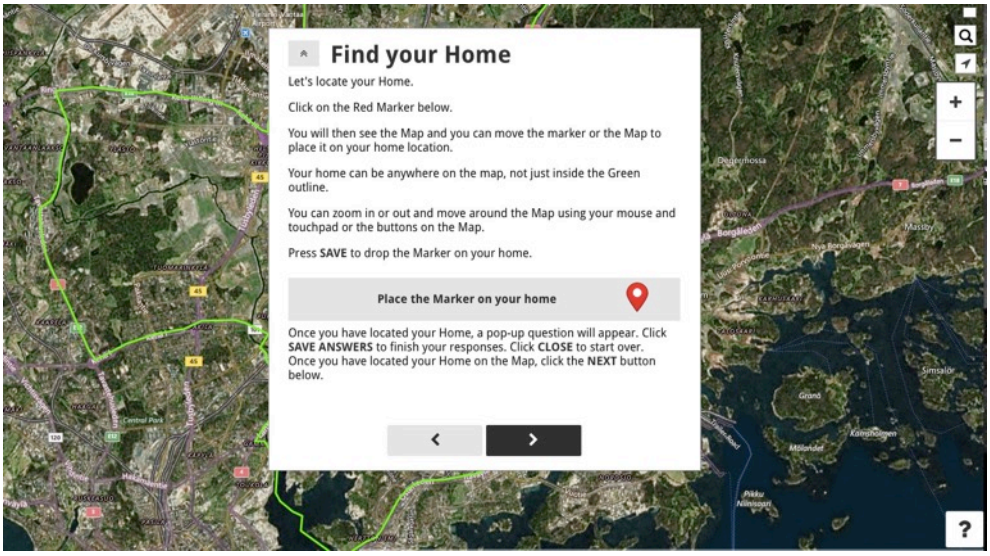
7.4.6 Survey Questionnaire Data Collection Structure

The SQ was divided into three distinct sections in order to collect Individual Factors, Landscape Factors and HWB Interaction Factors. After a brief introduction to the research purpose and explanation of key terms and principles, the SQ begins the data collection process. Appendix 8 provides a brief discussion and clarification of the data collection structure. Appendix 9 provides the complete SQ for each CA specific to each screen found within the on-line format. This section only provides an overview of important compnents of the SQ as related to data collection. The approximate SQ completion time was 10 - 15 minutes.

7.4.6.1 Part 1 – Demographic Data

Part 1 of the SQ collected demographic and individual socio-economic status data about individuals (See Figure 7.25). The goal of these front-end questions was to collect head of household information in order to correlate various demographic and socio-economic data. In order to limit respondent fatigue and asking standard survey questions, the included questions provided data that could not be collected through other means (i.e. secondary data collection).

For example, the SQ respondent was first asked to place a marker or geo-locate their home through the interactive, web-based map (See Figure 7.24). Once this marker was placed, a pop-up window appeared and they could then provide answers to four simple questions: age, gender, dog ownership, and car ownership. From the geolocated ‘Home’ location, secondary data such as various socio-economic datasets could be coordinated.



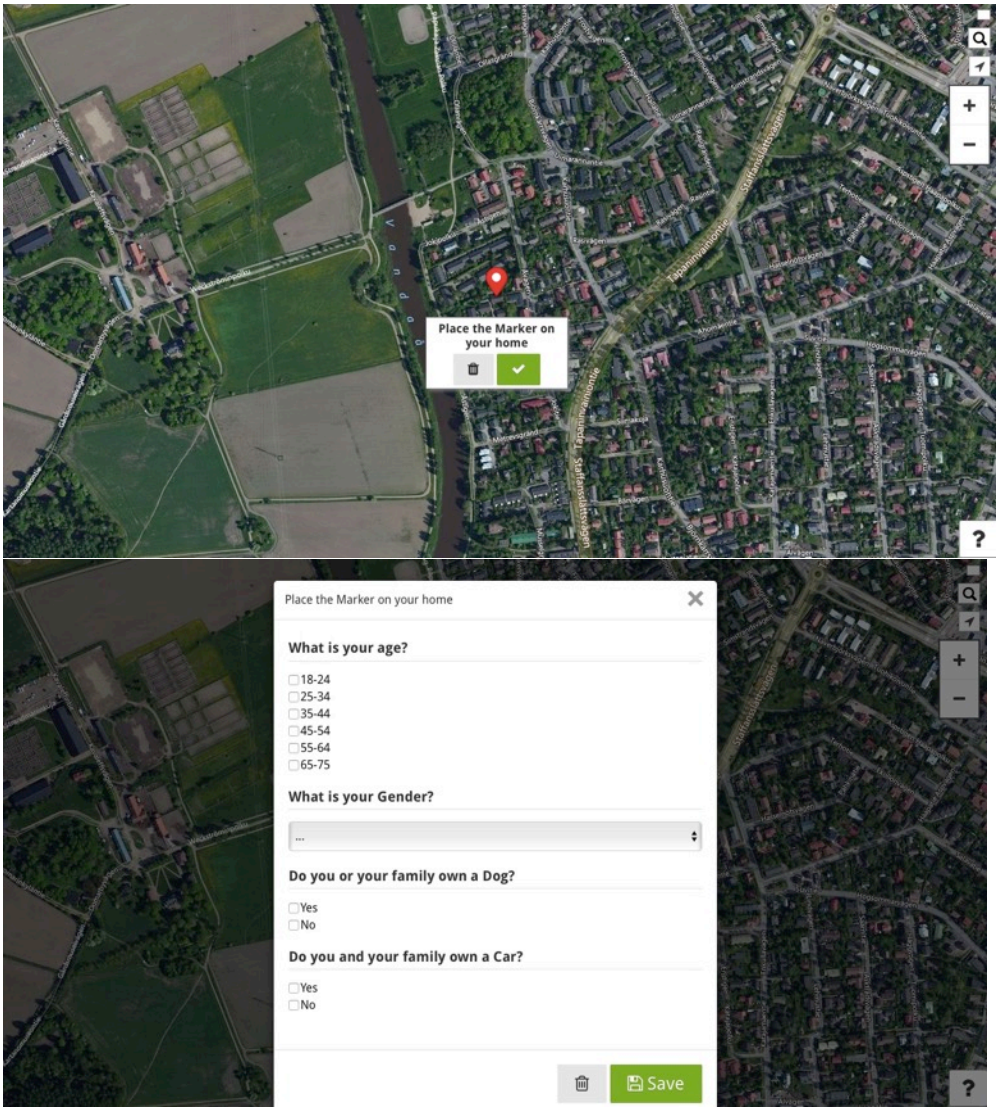


Figure 7.24
Screen Shots of SoftGIS Interface

Socio-Demographic Information (per SQ)
Home Location (geo-located on an interactive map)
Participant Age
Participant Gender
Household Dog Ownership
Household Car Ownership

Socio-Economic Information (per Geolocation Data)
At Risk of Poverty Threshold Ranking (Per geo-location);
Deprivation Quintile Ranking (Per geo-location);
Household Income Level (Average per Post Code);
Education Level (Average per Post Code).

Figure 7.25
Data Collected within the SoftGIS Interface

7.4.6.2 Part 2 – GS Interaction

Part 2 of the SQ used a series of questions designed to correlate specific, geo-coded GS locations to HWB affordances received from GS interaction in order to assess both specific PPUIGS structural and non-structural characteristics as well as their HWB measures. Part 2 first asked respondents to identify on the map (i.e. geo-locate and drop a marker) their three Favourite Green Spaces (FGS) (See Figure 7.26). Having done so, they were prompted with a similar pop-up window to pick one of three activities they did within the GS these answers were later coded to relate to Physical Wellbeing, Social Wellbeing and Psychological Wellbeing.

This data collection process within the SQ and pop-up windows is noted below:

What do you most often like to do in this Favourite Green Space when you visit? Please only pick one.

Recreate and Play Sports or other Activities
Be with friends and family, play with kids, or socialise
Relax, be quiet and enjoy nature

Respondents were then asked to note how the reached that particular FGS:

How do you usually get to this Favourite Green Space? Please check all that apply.

Walk
Bike
Car
Bus
Train

The FGS geo-location also included a question that asked the respondents to recommend any improvements to them. After each FGS was marked, the following appeared in which they could write-in their responses:

Are there any specific issues or problems at this Green Space?
Do you have any ideas for improvements to this Green Space?

Once all the FGS were marked, Part 2 then asked respondents to identify three other green spaces they visit, referred to as Other Green Space (OGS). The

purpose of asking for OGS is two-fold. Firstly, more than three GS markers are required for effective data analysis. Secondly, this differentiation between FGS and OGS provides a break in respondent fatigue and a means of satisfaction towards completion (See Figure 7.27). Both FGS and OGS markers (Landscape Factors) collect the same Affordance-based data (HWB Interaction Factors), albeit in slightly different formats.

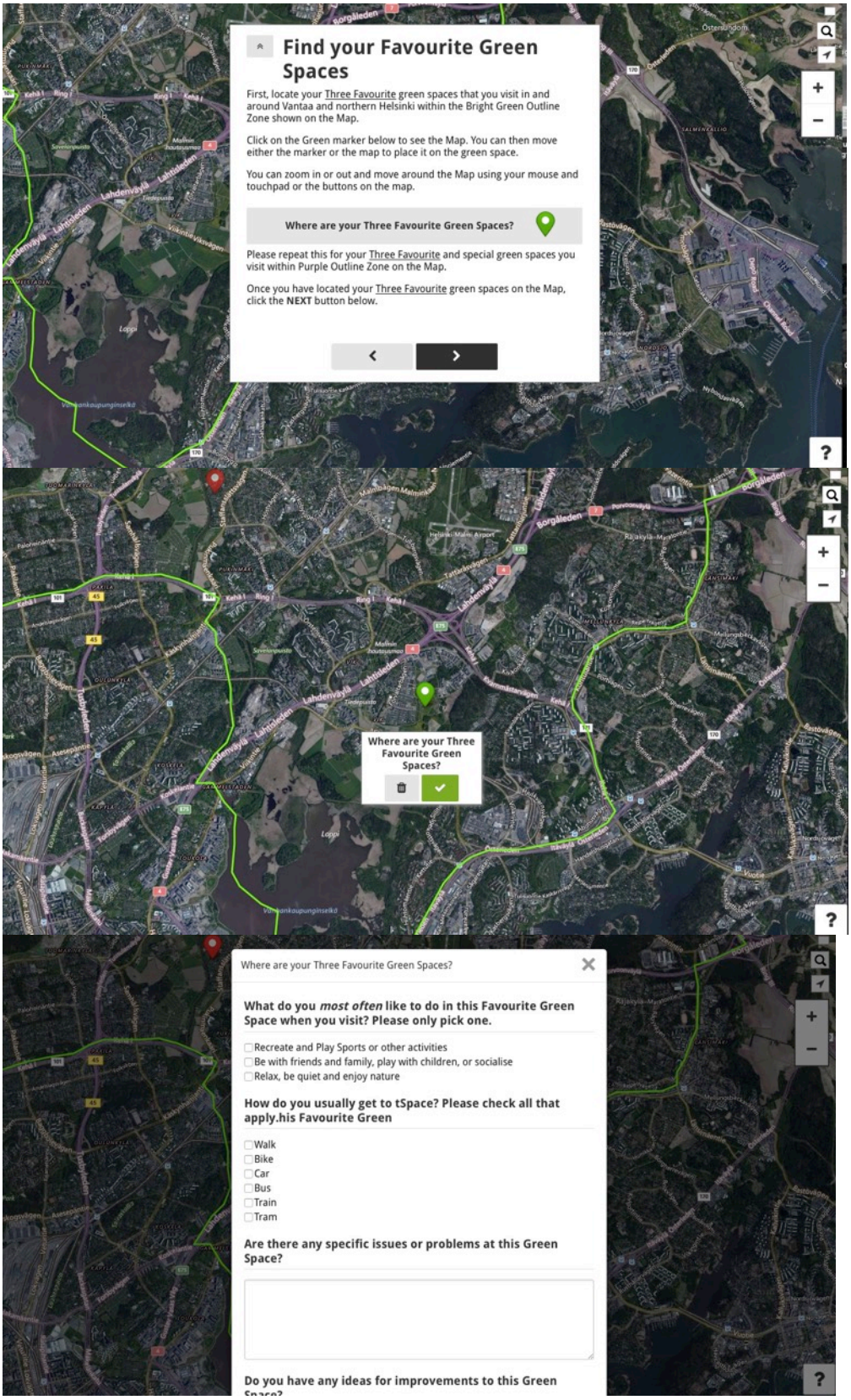


Figure 7.26
Screen Shots of Favourite Green Space Interface

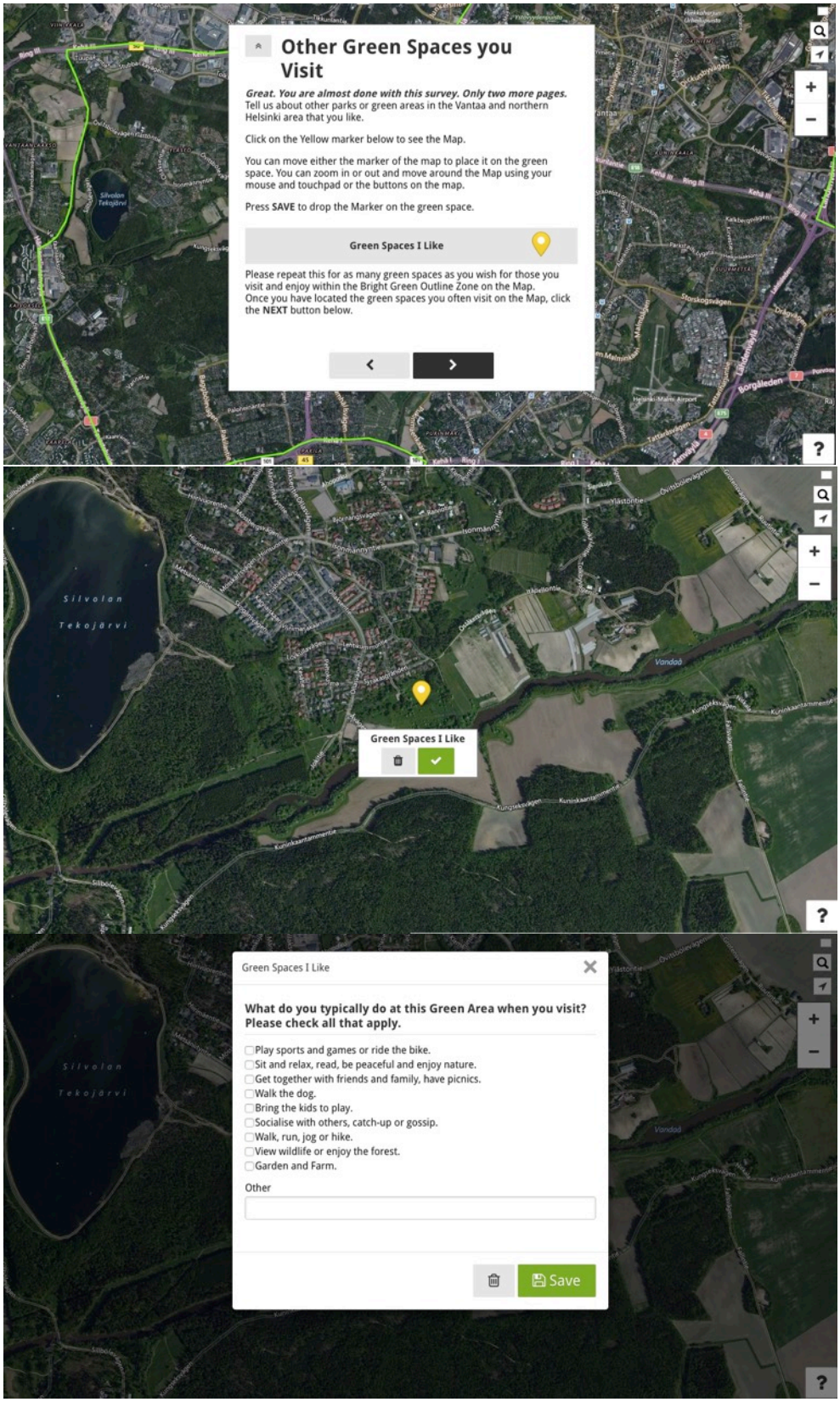


Figure 7.27
Screen Shots of Other Green Space Interface

Once the OGS was marked, a similar pop-up window would appear requesting the respondent to pick from a set of activities or interactions reflective of functional affordances they do within the OGS as per Figure 7.28.

What do you typically do at this Green Space when you visit? Please check all that apply.

- o Play sports and games or ride the bike.
- o Sit and relax, read, be peaceful and enjoy nature.
- o Get together with friends and family, have picnics.
- o Walk the dog.
- o Bring the kids to play.
- o Socialise with others, catch-up or gossip.
- o Walk, run, jog or hike.
- o View wildlife and special natural areas.
- o Garden and Farm.

Figure 7.28
OGS Pop-Up Affordance Questions

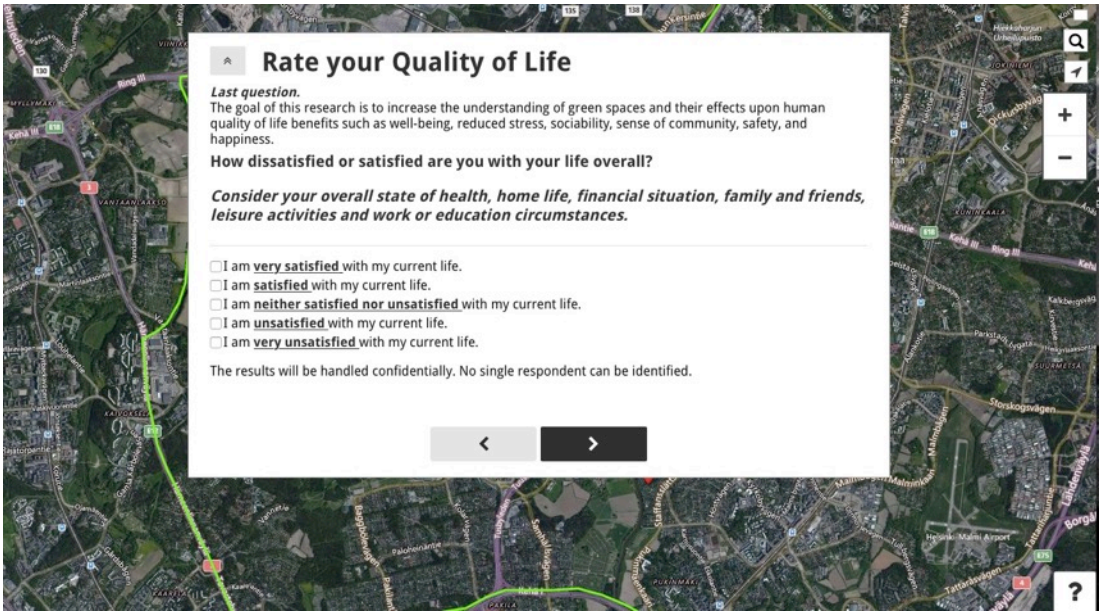
Part 3 – Self-Reported Life Satisfaction

Many prior studies were reviewed in order to determine the appropriate wording and Likert-scaling levels though they were predominantly within the Mental Health, Psychological, and Medical disciplines. This study was not a large, epidemiological survey with other QOL metrics that would justify a specific or targeted approach. Respondent fatigue and verbal clarity were considered prominently. Overall, a simple format similar to that utilised by the Institute of Medicine [29] (1997) was deemed the appropriate instrument to this study with slight modifications within the explanatory text to reflect GS affordance through interaction.

Part 3 of the SQ asked a single, simple 5-point Likert scale response based question on their current self-reported level of life satisfaction (See Table 7.6 and

[29] Institute of Medicine (IOM). *Improving Health in the Community*. Washington, DC: National Academy Press, 1997, 48-56.

Figure 7.29). Overall, this SQ's LS self-assessment question provides a simple composite indicator for a number of complex subjective and objective variables found within HWB measures.



How dissatisfied or satisfied are you with your life overall?

Consider your overall state of health, home life, financial situation, family and friends, leisure activities and work or education circumstances.

o I am very satisfied with my current life.

o I am satisfied with my current life.

o I am neither satisfied nor unsatisfied with my current life.

o I am unsatisfied with my current life.

o I am very unsatisfied with my current life.

Figure 7.29
Screen Shots of Life Satisfaction Ranking Interface

7.4.7 Case Study Socio-Cultural Landscape Analysis Instrument #2 – Official Statistics

In order to collect additional Individual Factor data not provided within the SQ, sarious readily-available socio-demographic datasets and official statistics such

as census and public health data were gathered to supplement the primary data collected through the SQ (See Table 7.7). This was completed through online data collection and included those provided by governments and their various agencies, departments, NGO's and councils. Appendix 14 provides the specific data sources for each set of data as well as their collection methodology and applied measurement levels.

Socio-Economic Information **(per Geolocation via Primary Postal Code)**
Household Income Level
Education Level
Deprivation Ranking (Paisley, Scotland)
At Risk of Poverty (Vantaa, Finland)

Table 7.6
Individual Factor Secondary Data Collected per Postal Code Geolocation

7.4.8 Landscape Structure and Green Space Characteristics Data Collection

Upon completion of the SQ, the specific GS (i.e. FGS and OGS) as noted by the participants had specific geospatial locations that could be futher analysed for the specific GS physical characteristics – their structural and non-structural landscape factors. These measurements were completed through the same instruments as the landscape fragmentation visual analysis, particularly site-visits and remote sensing.

This research's operationalised PPUIGS Characteristics Performance Measurement Index (See Figure 4.4) builds upon the PPUIGS Characteristics Performance Index discussed within Chapter 4 and shown in Figure 4.3. As discussed prior, this Index focusses on landscape services and landscape performance – both biophysical based (e.g. ecological integrity, patch dynamics) and anthropological based (e.g. QOL, HWB) - to better comprehend the complex and dynamic relationship found within the fragmented, polycentric PULs between humans and nature. This index simply provides the descriptive and evaluative values or measures to collect data and assess the current fragmented, eco-spatial state of the PPUIGS.

Chapter 8 - Results: Case Study Spatial Landscape Analysis

8.1 Case Study Visual Analysis Results of Landscape Fragmentation and Green Structure Characteristics

This section presents and discusses the results of the visual spatial landscape analysis foucsing on the landscape fragmentation and GS characteristics.

8.1.1 Visual Analysis Results: Orthophoto Imagery

This spatial analysis was completed through a cursory remote-sensed review at varied scales of the selected PURs and CAs to identify landscape fragmentation primarily assessing spatial heterogeneity, a typical indicator of landscape fragmentation (e.g. Saunders et al., 1991; Forman, 1995).

The identification of the spatial morphology of a landscape, particularly a fragmented landscape, is assisted through the use of photographic and map imagery. The ready availability of satellite imagery, orthophotos, infra-red imagery, and other remotely sensed images have progressed the study of urbanisation and landscape fragmentation (Luck and Wu 2002; Dietzel et al. 2005). Remote sensing and the use of orthophoto imagery and maps also contributes to the comprehensive representation of spatial heterogeneity, particularly along the urban-rural typology, as single dimensional data (e.g. conceptual modelling, representational modelling) can conceal important spatial patterns in land use and landscape features (Irwin and Geoghegan, 2001).

GoogleEarth allowed morphological analysis from a remote location and without environmental disturbances during the analysis such as rain, wind, or darkness. As a web-based source, GoogleEarth utilised current (2014) satellite imagery and/or orthophotos. Spatial zooming at various scales readily presented the various sizes, shapes, and distributions of the CAs landscape and GS morphology.

Figure 8.1 shows the scales selected for the visual analysis, however the actual images are not shown as they are utilised more poignately at later points. Both the accuracy and quality (i.e. resolution, boundaries, date) of the maps and photos were considered and researched with the best available imagery available. No figures or other output was produced.

Greater Glasgow Urban Region

Regional Scale 1:800,000

Glasgow Polycentric Urban Region

Metropolitan Scale 1:200,000

Paisley Conurbation Case Study Area

City Scale 1:100,000

Local Scale 1:20,000

Sources:

1. GoogleEarth

2. On-line access via Digimap:
http://digimap.edina.ac.uk
(2013 Colour Raster)

Helsinki Urban Region

Regional Scale 1:800,000

Helsinki Polycentric Urban Region

Metropolitan Scale 1:200,000

Vantaa Conurbation Case Study Area

City Scale 1:100,000

Local Scale 1:20,000

Sources:

1. GoogleEarth

2. On-line access via Vantaa Map Service:
http://kartta.vantaa.fi/#
Version Information: SpatialWeb - 7.0.49.0
(2013 Orthophoto)

Figure 8.1
Case Study Area Orthophoto Imagery Scales

The presence of diverse GS characteristics and typologies were confirmed. (See Figures 8.2 thru 8.9). Specifically, orthophoto spatial zooming with associated geospatial information such as location names helped discern GS typologies, their physical characteristics, and even management strategies. This analysis visually assessed these qualities, both vertically and horizontally; GoogleEarth Street View determined edge conditions of GS and other vertical characteristics.



Figure 8.2
Paisley Case Study Area: Green Structure Characteristics - Diversity
Scale: Local
Source: Google Earth, Digital Globe 2015

Even at this large scale, GS of various sizes, shapes, number of edges, their proximity to one another and if they are physically connected or not can be discerned.



Figure 8.3
Paisley Case Study Area: Green Structure Characteristics - Diversity
Scale: Neighbourhood
Source: Google Earth, Digital Globe 2015

At this scale, GS of various sizes, shapes, number of edges, their proximity to one another and if they are physically connected or not are more clearly illustrated. Additionally,vegetative characteristics such as if they are densely vegetated woodlands or open playfields are shown.



Figure 8.4

Vantaa Case Study Area: Green Structure Characteristics - Diversity
Scale: Local
Source: Google Earth, Digital Globe 2015

Even at this large scale, GS of various sizes, shapes, number of edges, their proximity to one another and if they are physically connected or not can be discerned.



Figure 8.5
Vantaa Case Study Area: Green Structure Characteristics - Diversity
Scale: Neighbourhood
Source: Google Earth, Digital Globe 2015

At this scale, GS of various sizes, shapes, number of edges, their proximity to one another and if they are physically connected or not are more clearly illustrated. Additionally, vegetative characteristics such as if they are densely vegetated woodlands or open playfields are shown.



Figure 8.6
Paisley Case Study Area: Green Structure Characteristics - Diversity
Scale: Street
Source: Google Earth, Digital Globe 2015

At this scale, GS charcteristcs of vegetation structure and composition such as natural or urban character as well as density of vegetation are illustrated.



Figure 8.7
Paisley Case Study Area: Green Structure Characteristics - Diversity
Scale: Detailed
Source: Google Earth, Digital Globe 2015

At this scale, facilities such as paths, structures, gardens and other features as well as whether the GS is highly managed/maintained or left to be more wild and natural can be seen.



Figure 8.8
Vantaa Case Study Area: Green Structure Characteristics - Diversity
Scale: Street
Source: Google Earth, Digital Globe 2015

At this scale, GS charcteristcs of vegetation structure and composition such as natural or urban character as well as density of vegetation are illustrated.



Figure 8.9
Vantaa Case Study Area: Green Structure Characteristics - Diversity
Scale: Detailed
Source: Google Earth, Digital Globe 2015

At this scale, facilities such as paths, structures, gardens and other features as well as whether the GS is highly managed/maintained or left to be more wild and natural can be seen.

8.1.2 Visual Analysis Results: Figure-Ground Diagrams

A landscapes morphological analysis is often assisted through a two-dimensional figure-ground diagram (Gibson, 1974). This provides information on the spatial unit(s) or particular morphology with respect to its background or context. The 'Ground' is the area surrounding the unit or 'Figure' (Arnheim, 1974) and, together, these show relational descriptions between the individual object and the larger landscape, including its forms, configurations and patterns. focusing on three specific aspects:

1. *Surface - traditional figure-ground of urban/non-urban area;*
2. *Line - linear elements;*
3. *Edge - transitional borders between urban/non-urban areas.*

This instrument utilised simple figure-ground maps at two scales, similar to those utilised in Instrument #1: Regional Scale (1:800,000 approximate) and Metropolitan Scale (1:200,000 approximate) (See Figures 8.10 thru 8.13). The region's morphology was analysed through the figure-ground diagrams with

specific interest in the region's visual density and visual pattern in order to assess landscape fragmentation characteristics.

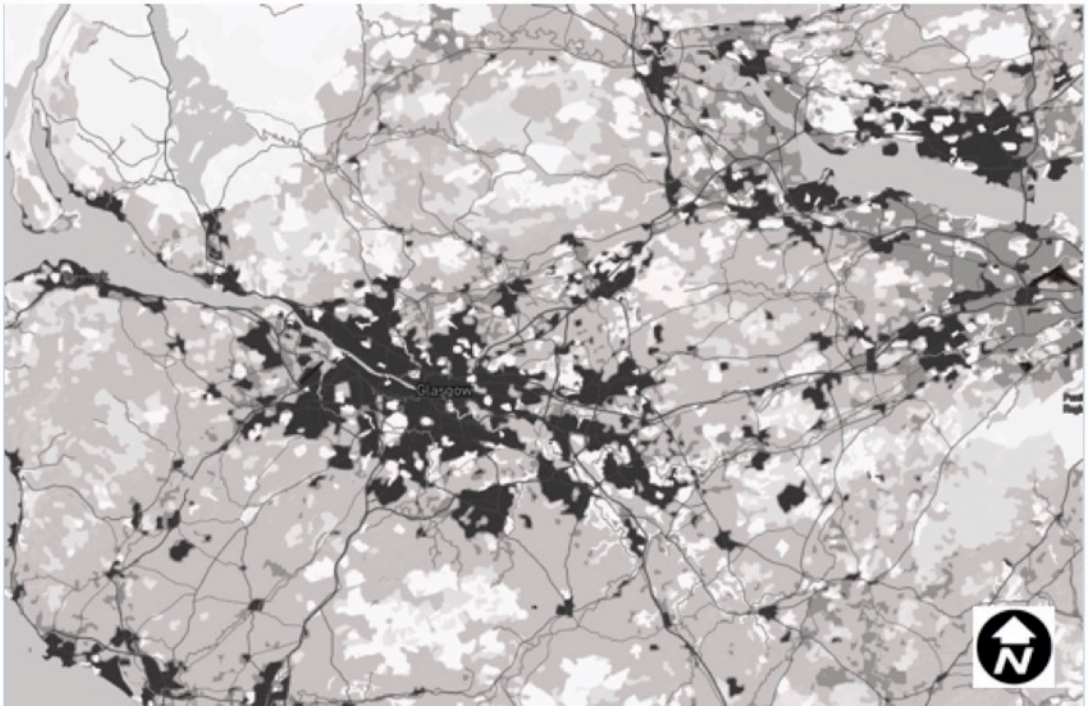


Figure 8.10
Figure Ground Diagram- Paisley Case Study Area
Areas of varying darkness (shades of grey) represent varying physical density levels (Very High Density, High Density, Medium Density, Low Density). No specific metrics are provided, this is a visual relational diagram only.
Scale: Regional
Source: Mapbox 2016

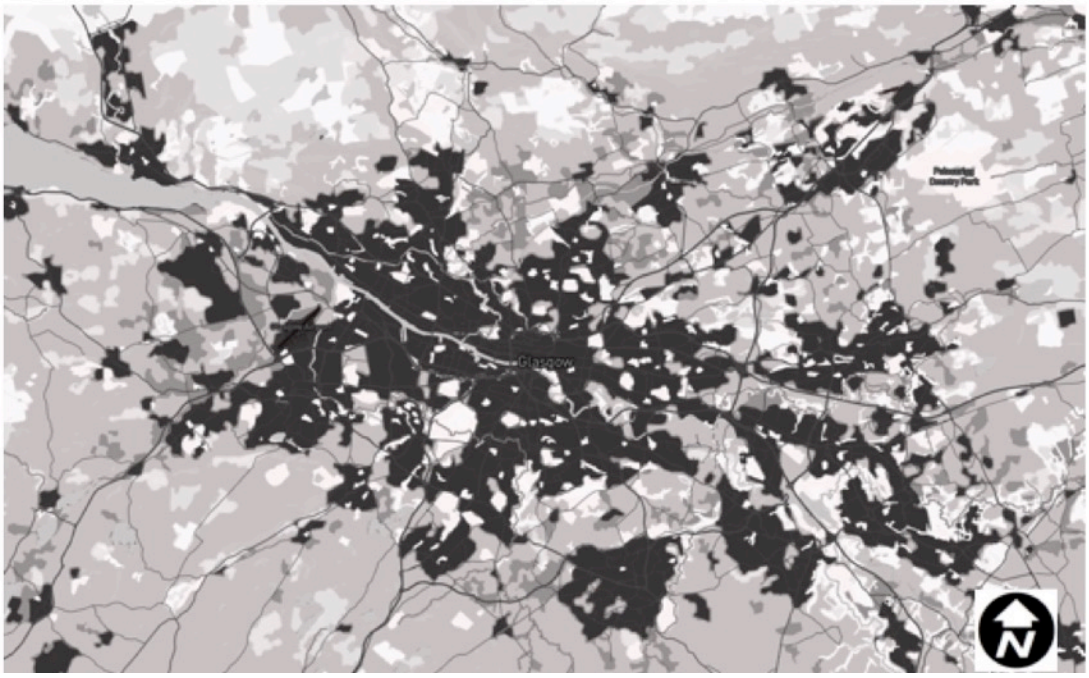


Figure 8.11: Paisley Case Study Area - Figure-Ground Diagram
Areas of varying darkness (shades of grey) represent varying physical density levels (Very High Density, High Density, Medium Density, Low Density). No specific metrics are provided, this is a visual relational diagram only.
Scale: Metropolitan - Source: Mapbox 2016

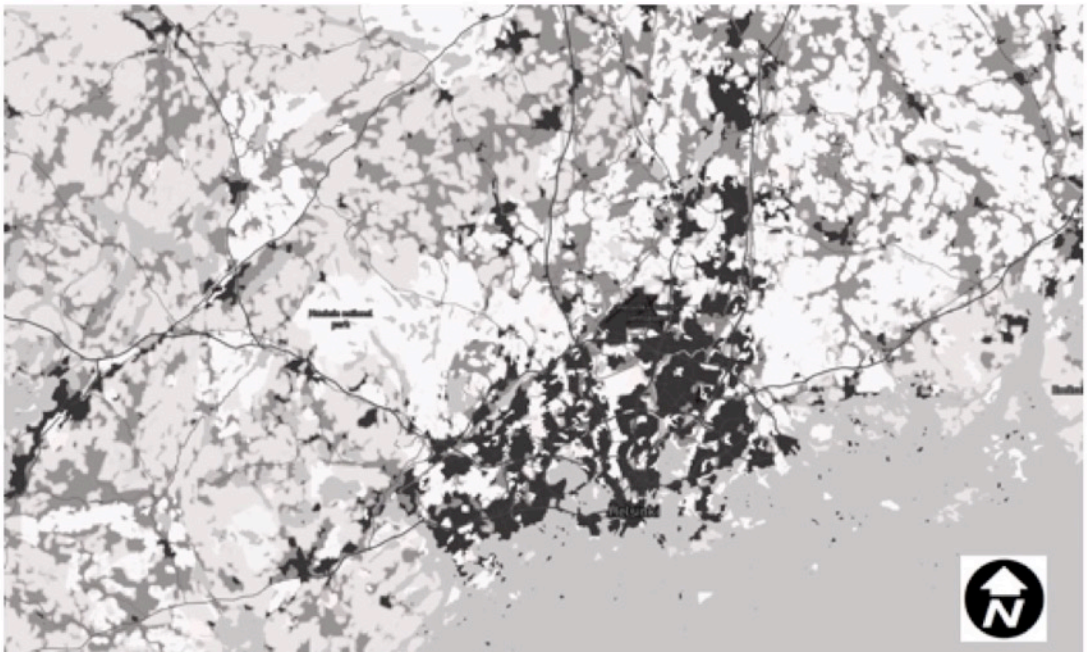


Figure 8.12: Figure Ground Diagram- Vantaa Case Study Area
Areas of varying darkness (shades of grey) represent varying physical density levels (Very High Density, High Density, Medium Density, Low Density). No specific metrics are provided, this is a visual relational diagram only.
Scale: Regional - Source: Mapbox 2016

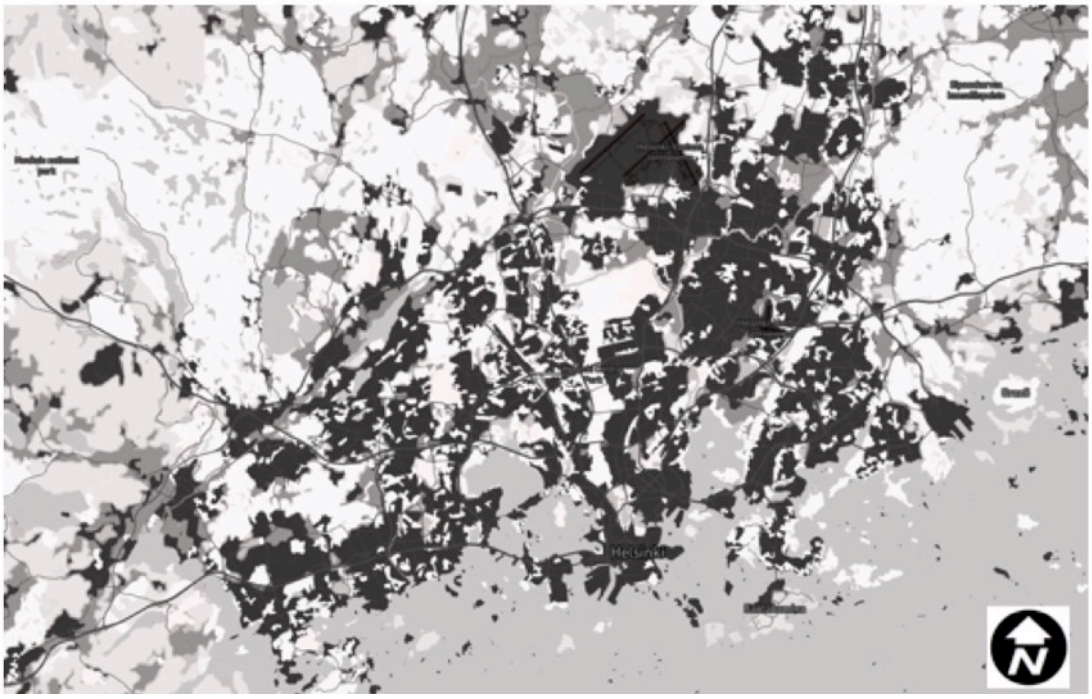


Figure 8.13
Figure Ground Diagram- Vantaa Case Study Area
Areas of varying darkness (shades of grey) represent varying physical density levels (Very High Density, High Density, Medium Density, Low Density). No specific metrics are provided, this is a visual relational diagram only.
Scale: Metropolitan
Source: Mapbox 2016

8.1.3 Visual Analysis Results: Spatio-Temporal Analysis

The landscape is not static; a visual analysis is typically a snapshot at a certain moment in time. Thus, a simple diachronic analysis was conducted which looked at spatial patterns and landscape structure through a historical orthophoto map and satellite imagery visual review. This instrument is best comprehended through a brief review of the historical development of the catchment area's polycentric sub-centre, the larger urban region and the central core, and the associated GS, to the best degree possible. The spatio-temporal analysis of the CAs cursorily reviewed the physical and structural change of the region over time and coalesced the many drivers and pressures of spatial landscape change throughout history with the subsequent state and impacts such as fragmentation on the landscape, all from a distinctly spatial and morphological perspective.

Case Study Area #1 - Paisley and the Greater Glasgow Urban Region, Scotland

Glasgow Urban Structure

The physical growth of Glasgow can be divided into a number of periods:

Medieval Glasgow (before 1600)

St. Mungo founded the city of Glasgow in the 6th century and constructed a small church. After a small bridge was built to cross the River Clyde to which enabled north-south travel, a trade market developed in the 12th century.

17th and 18th Centuries

Modifications to the River Clyde in the 17th century increased both the size and quantity of trade in Glasgow, soon becoming the main port in west Scotland, lessening the importance of Port Glasgow just downriver.

19th Century

The Industrial Revolution impacted Glasgow perhaps more than any other city in Europe. Various factories and manufacturing industries added to the shipbuilding commerce of the city that required workers and housing. Tenement housing, or multi-occupancy housing, was created within the city's urban districts to house these new workers. The population of Glasgow expanded to more than 1 million during this period.

20th Century

The sharp decline in Glasgow's manufacturing demand and population began in the early 20th century, however, the physical size of the city increased through large housing estates on the city's rural edge during the 1950's in Easterhouse and Drumchapel and others. Further housing for the inner-city population's emigration included private housing estates in the suburban areas of Bishopbriggs and Newton means in the 1960's. (Aitken, 2012)

21st Century

Since the early 2000's, Glasgow City Council has attempted to stop out-migration through various schemes, the most notable being increasing tourism and investment in the city's infrastructure for business and finance. Riverside and industrial regeneration has seen new construction for finance, culture, sports, and

housing. Out-migration from Glasgow has continued overall, but recently (2015) Glasgow's population size increased by nearly 400 people, mostly due to EU Accession Country immigration and asylum seekers (retrived from: http://www.glasgowvant.com/visitors-guide-to-glasgow/glasgow-facts-figures/).

Greater Glasgow Urban Region Structure

The physical structure of the GGUR is intimately tied to its core, Glasgow. As a major industrial city during the 19th and 20th century, Glasgow had a very large inner city area based around the River Clyde where the factories and shipyards were located. As such, a typical circular-shaped ring of industry and housing did not develop (i.e. the River Clyde is a linear form). The lack of river crossings such as bridges due to these maritime industrial needs meant the city was limited in outward expansion to accommodate housing needs. The Campsie hills in northern Glasgow were too steep and boggy wetlands in the other peripheries required urban densification within the centralised City (Brennan, 1959).

Similar to many UK and European urban areas, the GGUR's spatial form was impacted by the outward growth and expansion of its urban centre, Glasgow, to accommodate housing and commerce. As with most UK cities, post-industrial and post-war urbanisation occurred at the periphery of the urban centre and in the PUAs; Glasgow was not exempt from this urbanisation pressure. Glasgow is currently (2016) not physically expanding; physical growth and urbanisation is and has been occurring in Glasgow's PUR - the Glasgow City Region and the GGUR - since the 1980's (See Figure 8.14).

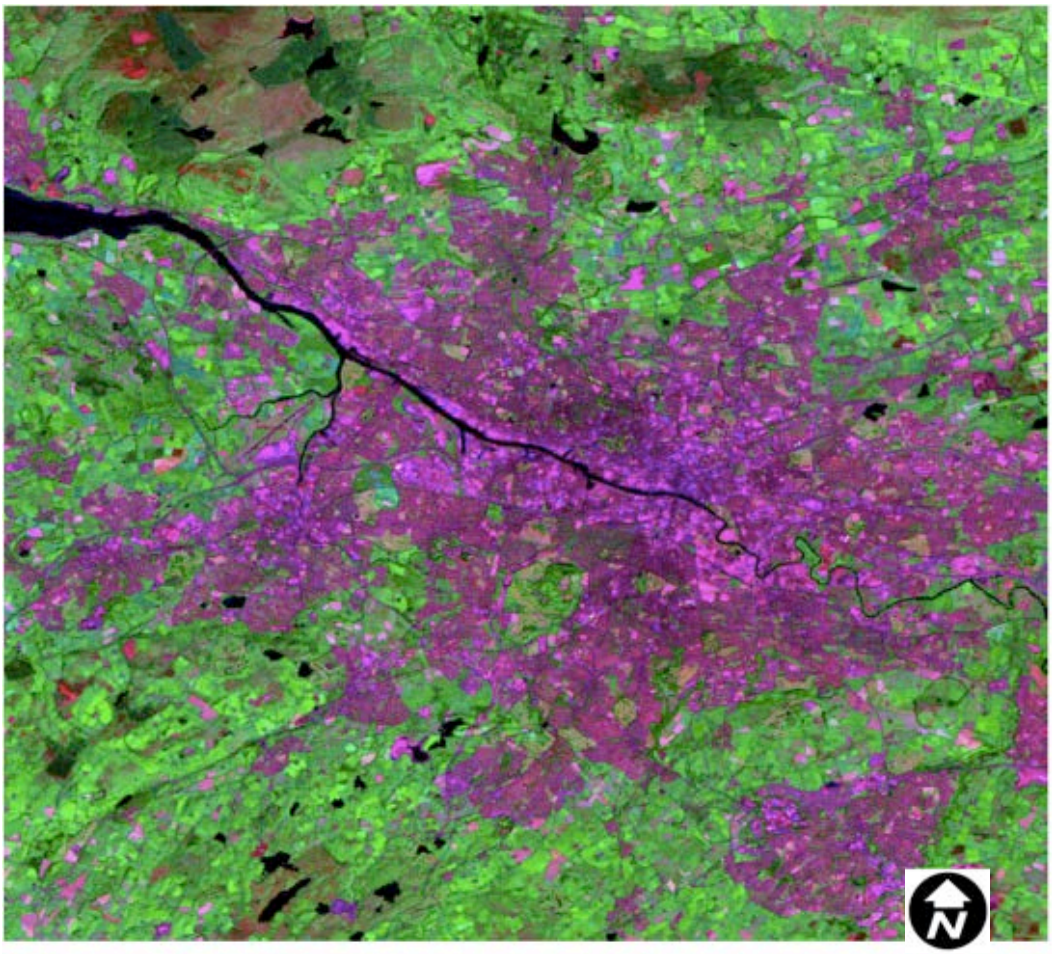


Figure 8.14
Greater Glasgow Urban Region
False-colour satellite image, darker areas
showing the physical extent and intensity of urbanisation.
Areas of varying lightness (shades of purple) represent varying physical density levels (Very High Density, High Density, Medium Density, Low Density). No specific metrics are provided, this is a visual relational diagram only.
(Source: Maantay, J. A., 2013. Derelict Land, Deprivation, and Health Inequality in Glasgow, Scotland: The Collapse of Place)

Glasgow's urban centre has lost over half its population since its peak in 1951. GGUR's development spread in a multi-nodal, star pattern with Glasgow as a core or centre. Within the PUR of Glasgow are a series of conurbations, this gives the region its polycentric form. Glasgow is surrounded by a number of these secondary centres. Many of these - Greenock, Paisley, Hamilton, Motherwell, Coatbridge and Airdrie - expanded quickly along with Glasgow as the region industrialised in the 19th century. Similar to Glasgow City, these conurbations experienced economic decline in the post-war period, though the associated impacts

were not as marked as Glasgow City, mostly due to increase in population and employment opportunities due to decentralisation from it's core, Glasgow.

Polycentric Sub-Centre Structure - Paisley

The spatial form of the GGUR is distinctly polycentric. Paisley is an important sub-centre within the overall region's conurbation, both functionally and morphologically. Paisley is the largest town in the Renfrewshire council area and serves as its administrative centre.

Historically, Paisley became an important religious destination in the 12th century through the Paisley Abbey. Physical growth continued steadily, albeit slowly, and was a farming community for this period. In the early 19th century, Paisley evolved into an industrial-textile city and became a world-centre for weaving. By the mid 19th century, like Glasgow and many other industrial towns around the UK, sharp manufacturing decline led to high unemployment and mill closings. (http://www.paisley.org.uk/paisley-history/)

Paisley is a prototypical example of polycentric development. Yet, questions arise when analysing GGUR's and Paisley's polycentric development:

Is Paisley a node within GGUR's polycentric system or is it just one suburb of many within the Glasgow monocentric metropolitan region?

Literature would argue that Paisley is polycentric (Bailey and Turok, 2001; Douglas, 2012). Because Paisley is both a functional and spatial polycentric conurbation, Paisley is not a suburb or extentsion of Glasgow. As shown prior, it met all criteria for a polycentric conurbation.

Are the polycentric conurbations within the GGUR such as Paisley and Motherwell fragmented themselves or just fragmented components of the larger peri-urban region?

This question requires the appropriate perspective and context to answer clearly. In the context of spatial morphology, the answer is yes to both questions. Paisley not only exists within the fragmented state of the GGUR, but also exists fragmented within it's own particular spatial morphology. Paisley is spatially fragmented within the larger spatially fragmented GGUR.

Additionally, there is literature that states that Glasgow is actually part of the larger Edinburgh-Glasgow Urban Region (Bailey and Turok, 2001). In fact, as early as 1915, Patrick Geddes noted the continued expansion of Glasgow and Edinburgh due to the transport connections between them, a unified conurbation would be created (Geddes, 1968). Geddes may have been correct in this vision were it not for the strong economic decline of Glasgow. However, this author notes that spatially, the Edinburgh-Glasgow Urban Region will likely evolve in the future.

Historical and Spatio-Temporal Maps

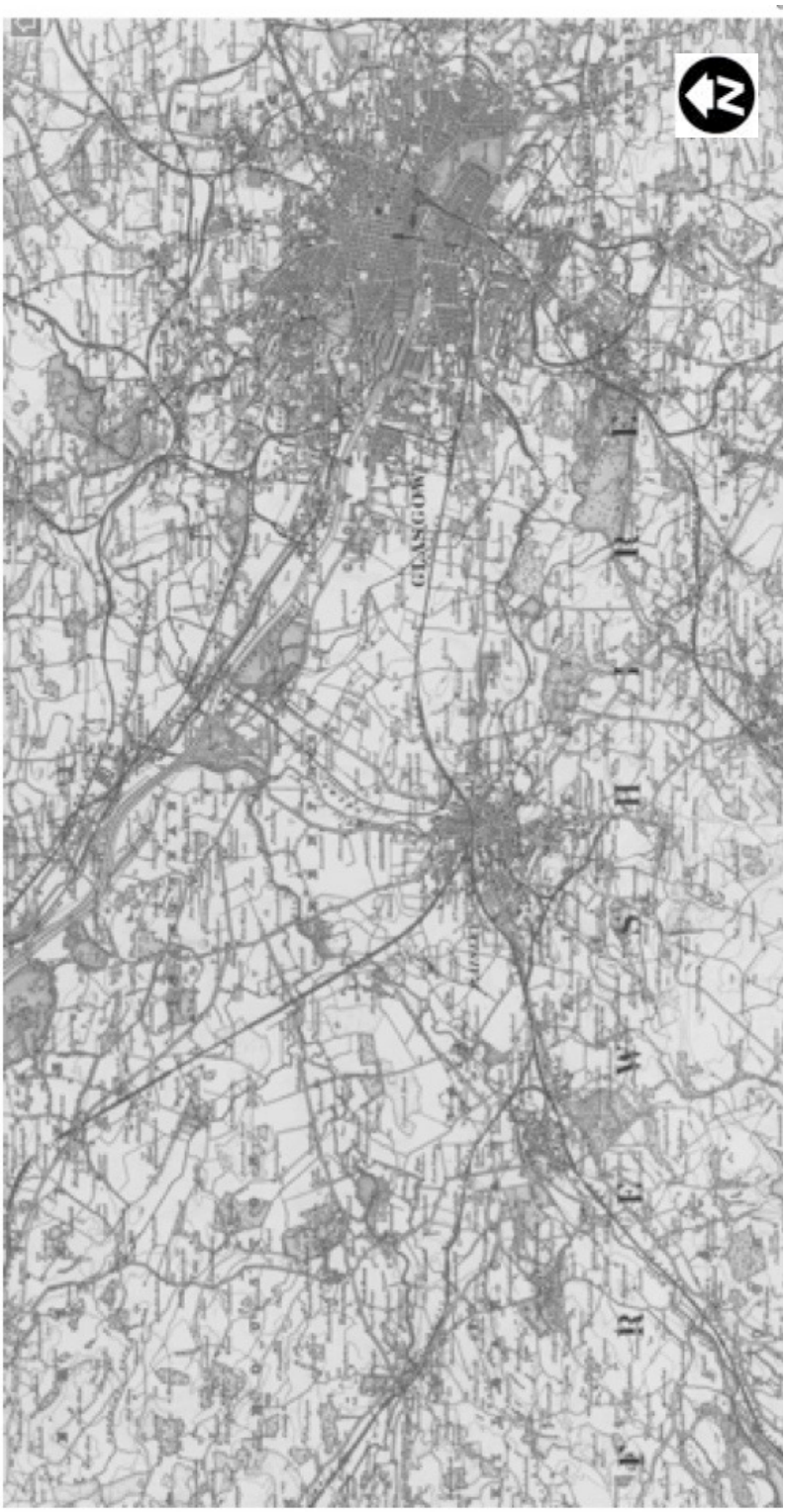


Figure 8.15
Paisley Case Study Area: Historical Map – 1885-1900
Scale: Local
Source: OS One Inch 1885-1900 Outline
National Library of Scotland (NLS) - http://maps.nls.uk



Figure 8.16
Paisley Case Study Area: Historical Map – 1955-1961
Scale: Local
Source: OS One Inch 7th Series, 1955-61
National Library of Scotland (NLS) http://maps.nls.uk



Figure 8.17
Paisley Case Study Area: Historical Map – 2012
Scale: Local
Source: Digimap OS

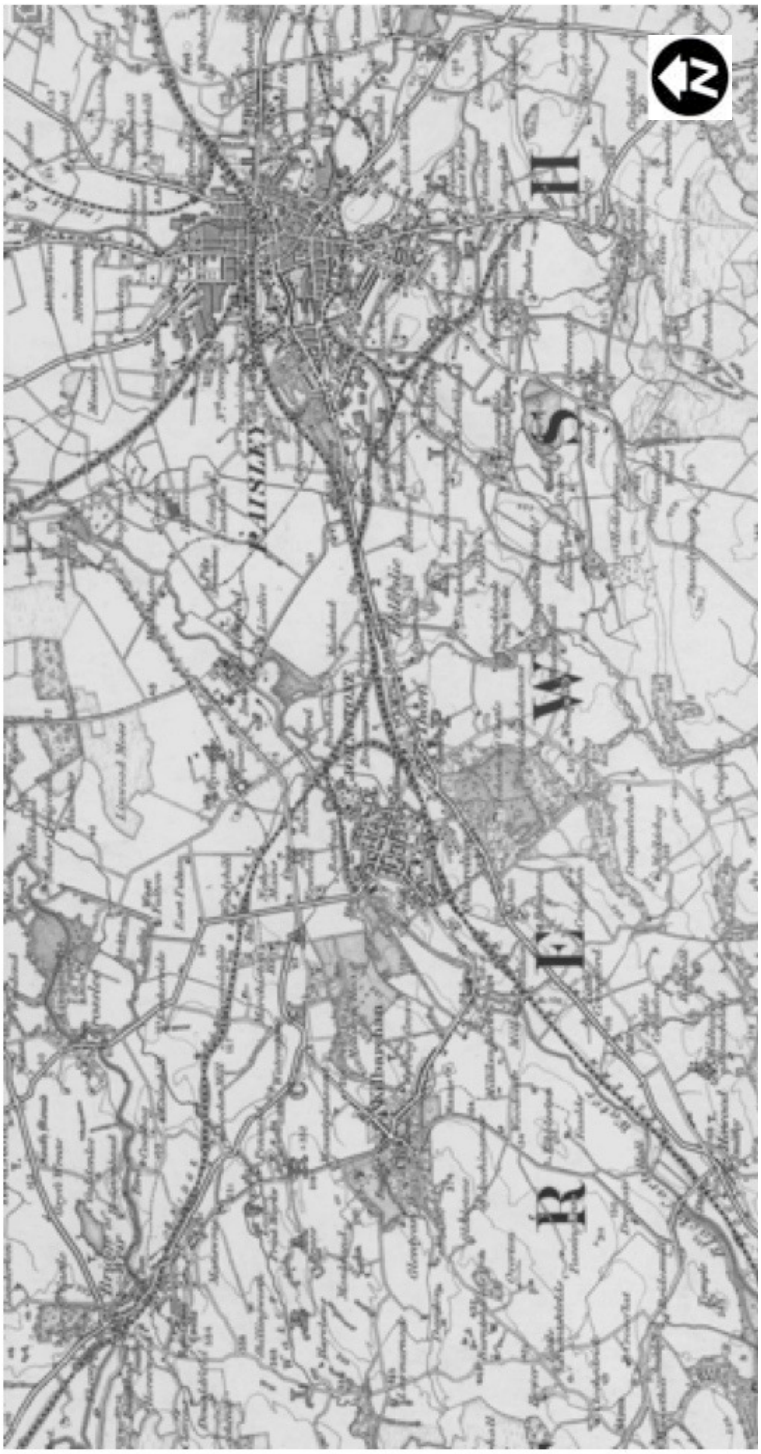


Figure 8.18
Paisley Case Study Area: Historical Map – 1885-1900
Scale: Neighbourhood
Source: OS One Inch 1885-1900 Outline
National Library of Scotland (NLS) - http://maps.nls.uk



Figure 8.19
Paisley Case Study Area: Historical Map – 1955-1961
Scale: Neighbourhood
Source: OS One Inch 7th Series, 1955-61
National Library of Scotland (NLS) http://maps.nls.uk



Figure 8.20
Paisley Case Study Area: Historical Map – 2012
Scale: Neighbourhood
Source: Digimap OS

Case Study Area #2 - Helsinki and the Helsinki Urban Region, Finland

Helsinki Urban Structure

The physical growth of Helsinki can be divided into a number of periods:

Pre 16th Century

Originally the city of Helsinki was founded about six kilometres to the north of the present city centre, at the mouth of the river Vantaa in 1550 by the King of Sweden, Gustavus Vasa. This settlement was with the purpose of making Helsinki a significant city of trade, and Sweden invested people and resources to this project, which ultimately failed.

17th and 18th Centuries

Helsinki remained small until about 1640 when the port became important for the staging and transfer of troops, horses and supplies for the wars in the 17th Century. The central core of Helsinki was moved to this current city centre.

19th Century

Helsinki became the capital of Finland in 1812 as allocated by the Russian Czar. The Russian influence consolidated Helsinki with a University and governance centre, prompting much development within the City's core by means of a grid square town structure including those in Vantaa and Espoo. This structure led to the development of stone housing for the city's upper classes and wooden structures within the worker suburbs (Helsinki Cost c11, 2003). The industrialisation of Helsinki in the 1880's increased its population significantly moving forward.

20th Century

Finland achieved independence in 1917. Helsinki continued with steady development in the 20th century and hosted the Olympic Games in 1952, which prompted migration to the City. Rapid urbanisation occurred in the late 1960's and 1970's, noted as relatively late when compared to the rest of Europe, and saw Helsinki's metropolitan population triple.

Helsinki's suburban settlements were well-separated with traditionally wooden-based construction, encompassing an agriculture and forestry commerce until post-war 1950's. Instigated by technological innovation, and lack of forestry

and agricultural economic stability, migration from the countryside, specifically to Espoo and Vantaa, and brought significant urbanisation and suburbanisation to the Helsinki region, referred to as the 'Great Move'. Because of the late urbanisation, the building stock especially in urban settlements is new: 85 % of the buildings were constructed after 1950. The 'Great Move' included neighbourhoods developed far from the city centres, not on the urban fringe. Finland and the HUR embraced the modernist movement inclusive of functionalist perspectives in this urban expansion and resultant physical structure upon the landscape. Thus, fast and efficient housing was built on these inexpensive, rural parcels of land, well beyond existing urban land uses or land covers (Hiltunen, 1998).

Helsinki's urbanisation slowed in the 1970's but in the 1980's this trend proliferated again, specifically in the suburban regions, often in response to the dense, unhealthy residential structures built in the 1950's. Thus, the region around Helsinki contains mostly single-family, detached homes. Steady migration from the rural areas of Finland to Helsinki was maintained during this period. The early 1990's saw the economic downtown in much of Europe impact Helsinki that limited growth and urbanisation. However, the technology sector brought rapid urbanisation back to Helsinki in the late 1990's.

21st Century

The City of Helsinki has seen urban regeneration projects proliferate, attracting young Finns moving back to the City. In-migration from the rural areas is steady, with some foreign migration. The current focus is towards density, with many urban areas seeing regenerated structures.

Helsinki Urban Region Structure

The physical structure of the HUR is intimately tied to its core, Helsinki. Helsinki is a water-based city, and its growth has been affected by this geography. Helsinki's post-industrial and post-war growth was unlike other European cities not in its form, but in its timing. As with most European cities, Helsinki's post-industrial and post-war growth occurred at the periphery of the urban centre and in the peri-urban areas, however this growth did not occur until the 1970's in the HUR. Bridges to the east and west increased suburbanisation during this period;

and since the 1980's the commuting area of Helsinki has extended gradually to a distance of 100 km, in a star like shape along the main traffic lines. Since the early 2000's, Helsinki has grown within the City's municipality thru infill densification and overall within the HUR. Regional urbanisation pressures continue today (2016).

Polycentric Sub-Centre Structure - Vantaa

The spatial form of the HUR is distinctly polycentric. Vantaa is an important sub-centre within the overall region's conurbation, both functionally and morphologically.

Historically, Vantaa developed around the Vantaa River, first in 1351 for fishing access. The ore and mining industry of the 1700's led to rapid development of Vantaa. The Finnish railway made Vantaa one of its seven stops and this allowed further population to the area in the late 19th century. Since the 2000's, Vantaa has served as an area for families with children. Currently, the Helsinki-Vantaa airport is as an important regional destination. In-migration, particularly after World War II, has led to Vantaa's population increase as residents moved from more rural areas.

Historical and Spatio-Temporal Maps

The following maps illustrate spatial change in the CAs. These historical maps also offered an important feature that allowed the satellite image base-map's opacity to be manipulated, thus providing a clear illustration of existing conditions (via satellite image) and the historic condition simultaneously (See Figure 8.27).

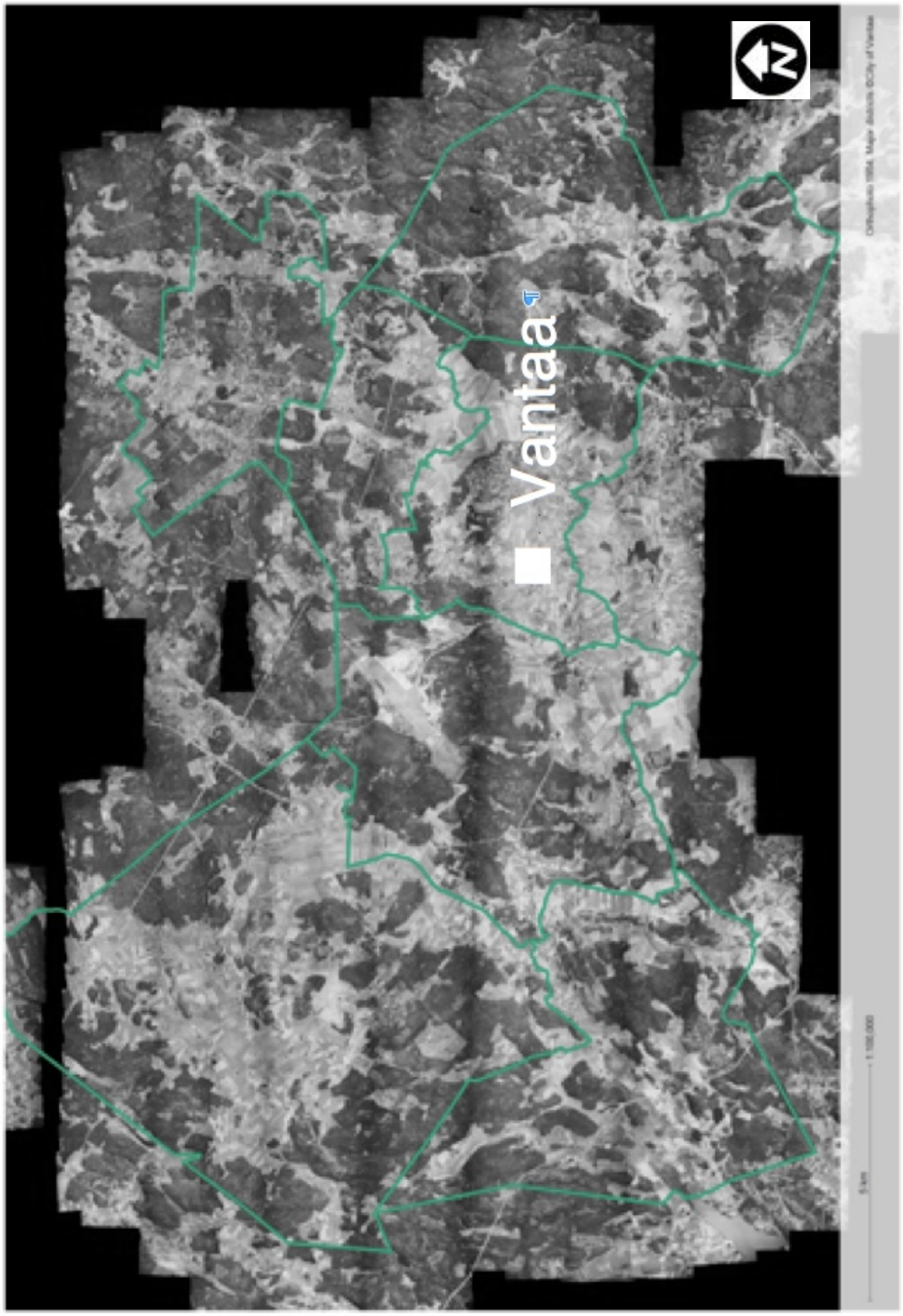


Figure 8.21
Vantaa Case Study Area Historical Map – 1954
Scale: Local
Source: Orthophoto 1954, Vantaa Map Service - http://kartaa.vantaa.fi



Figure 8.22
Vantaa Case Study Area Historical Map – 1998
Scale: Local
Source: Orthophoto 1998, Vantaa Map Service - http://kartaa.vantaa.fi

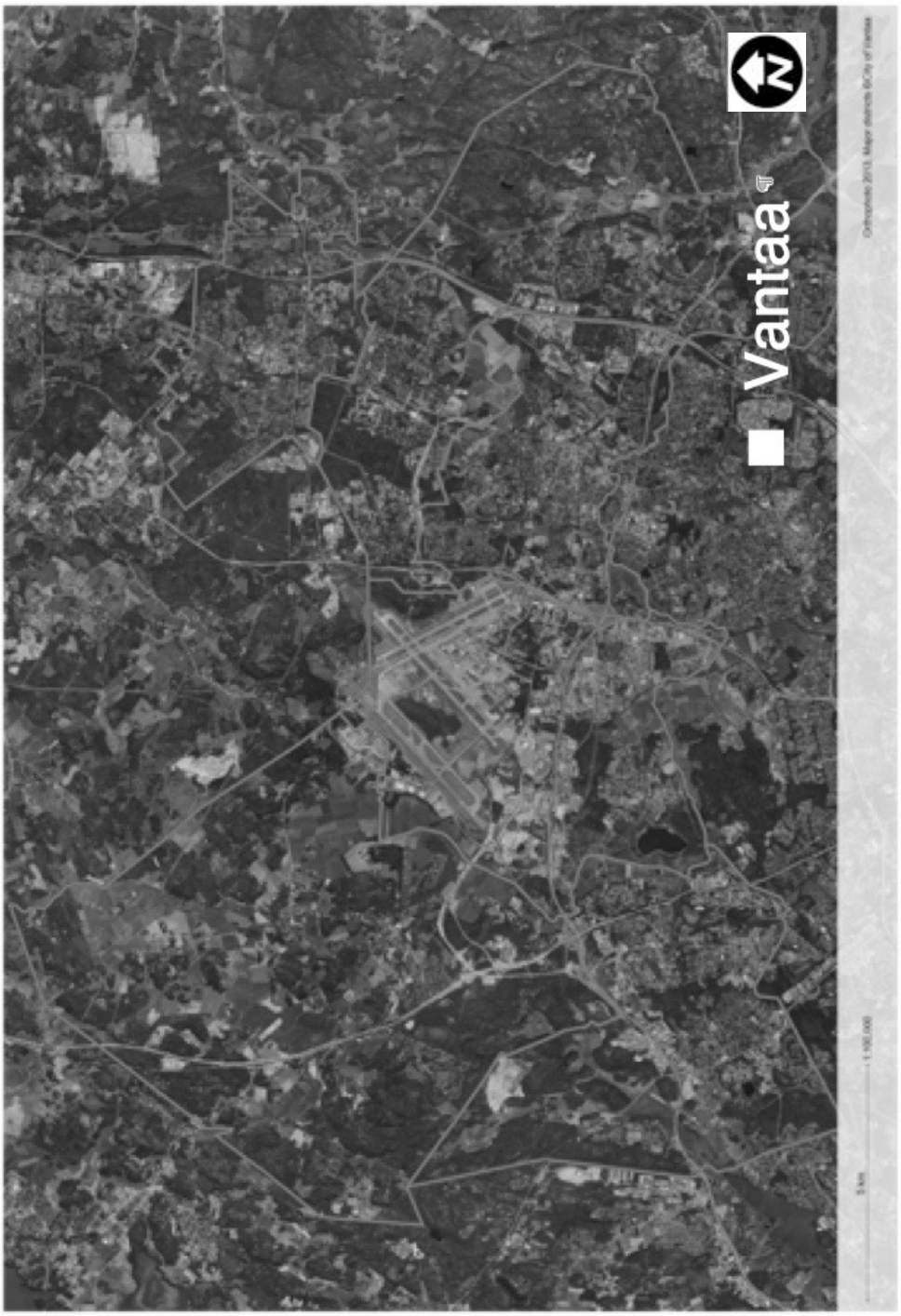


Figure 8.23
Vantaa Case Study Area Historical Map – 2013
Scale: Local
Source: Orthophoto 2013
Vantaa Map Service – http://kartaa.vantaa.fi

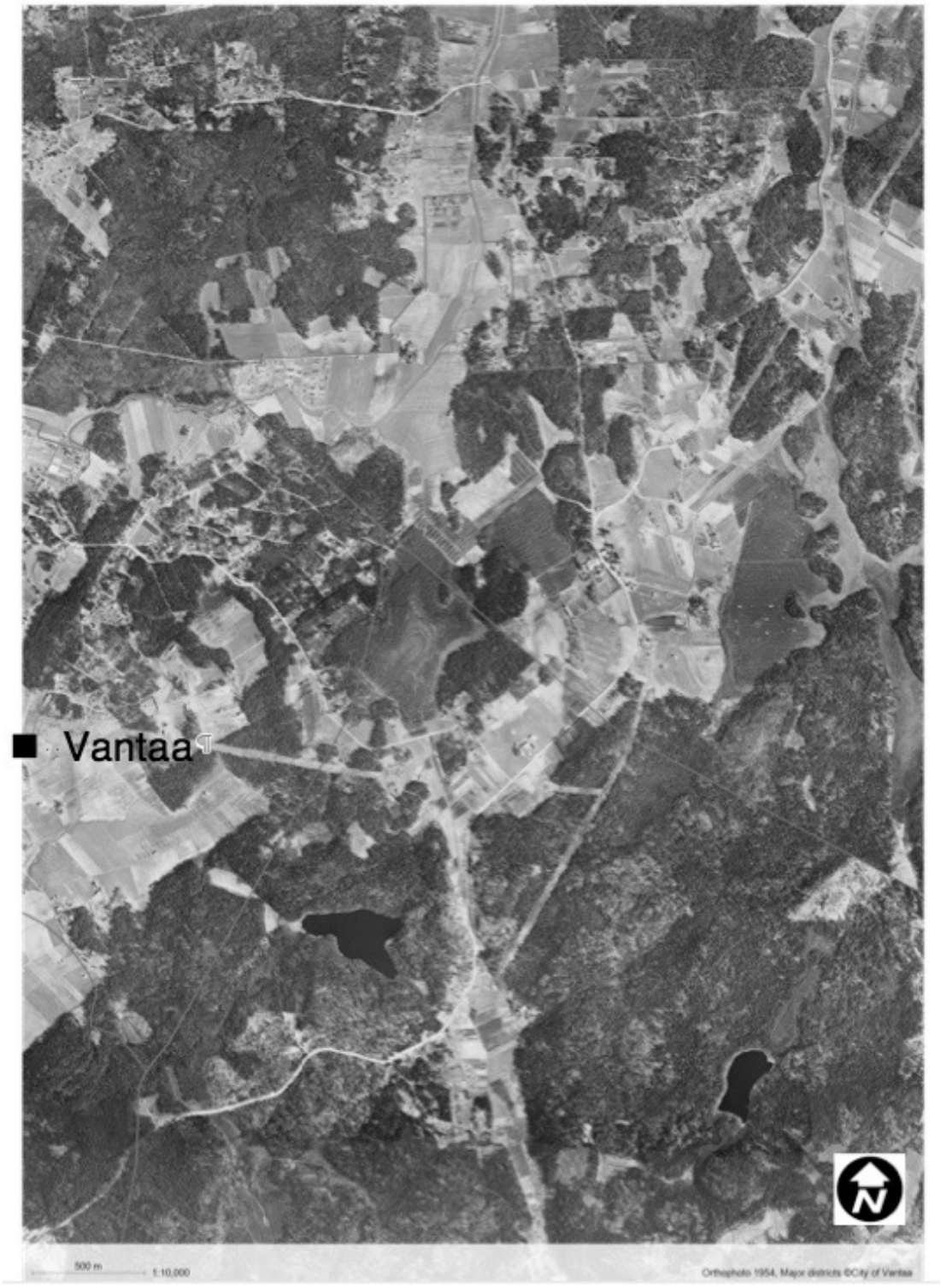


Figure 8.24
Vantaa Case Study Area Historical Map – 1954
Scale: Neighbourhood
Source: Orthophoto 1954, Vantaa Map Service – http://kartaa.vantaa.fi



Figure 8.25
Vantaa Case Study Area Historical Map – 1998
Scale: Neighbourhood
Source: Orthophoto 1998, Vantaa Map Service - http://kartaa.vantaa.fi

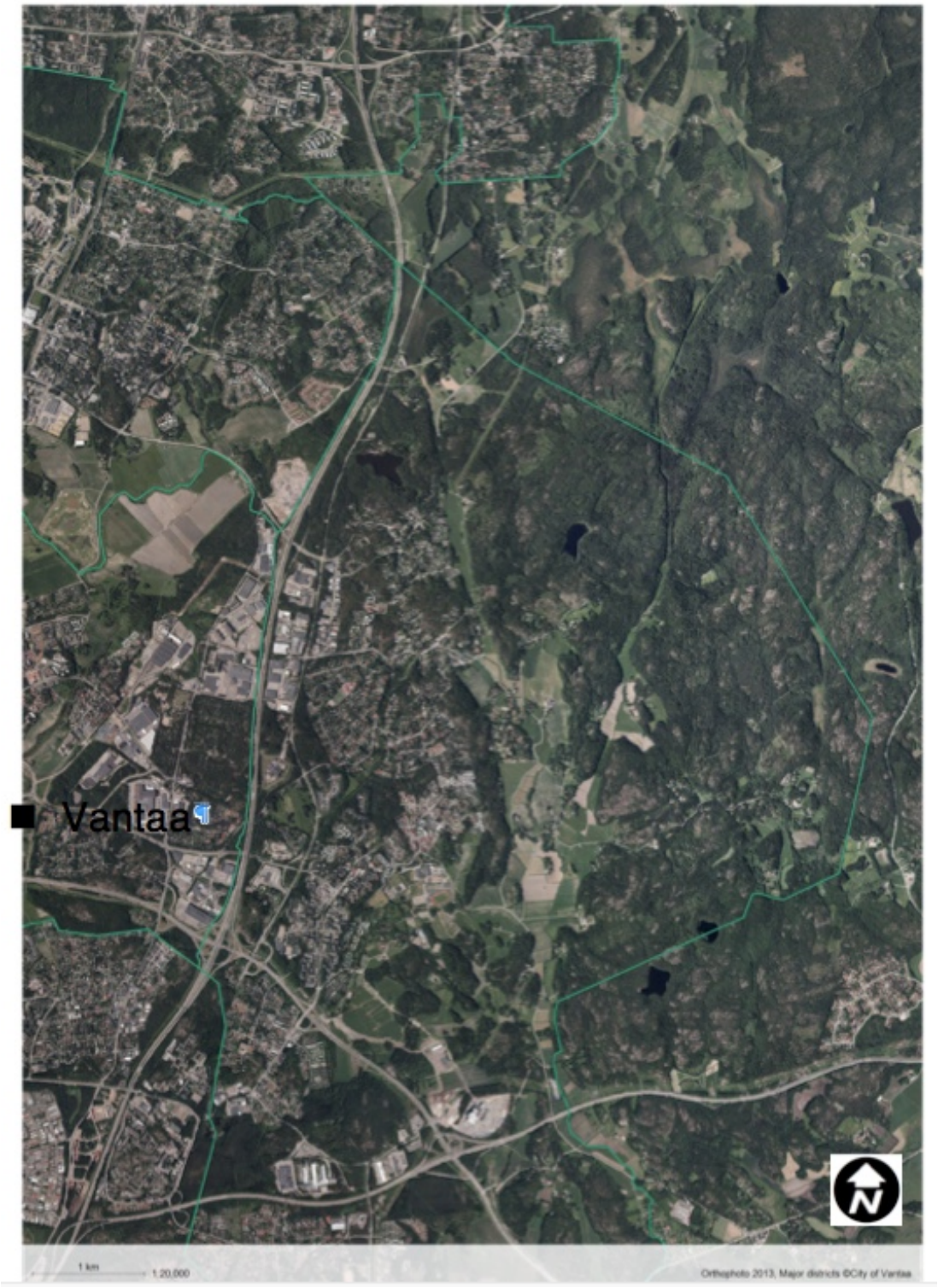


Figure 8.26
Vantaa Case Study Area Historical Map – 2013
Scale: Neighbourhood
Source: Orthophoto 2013, Vantaa Map Service – http://kartaa.vantaa.fi

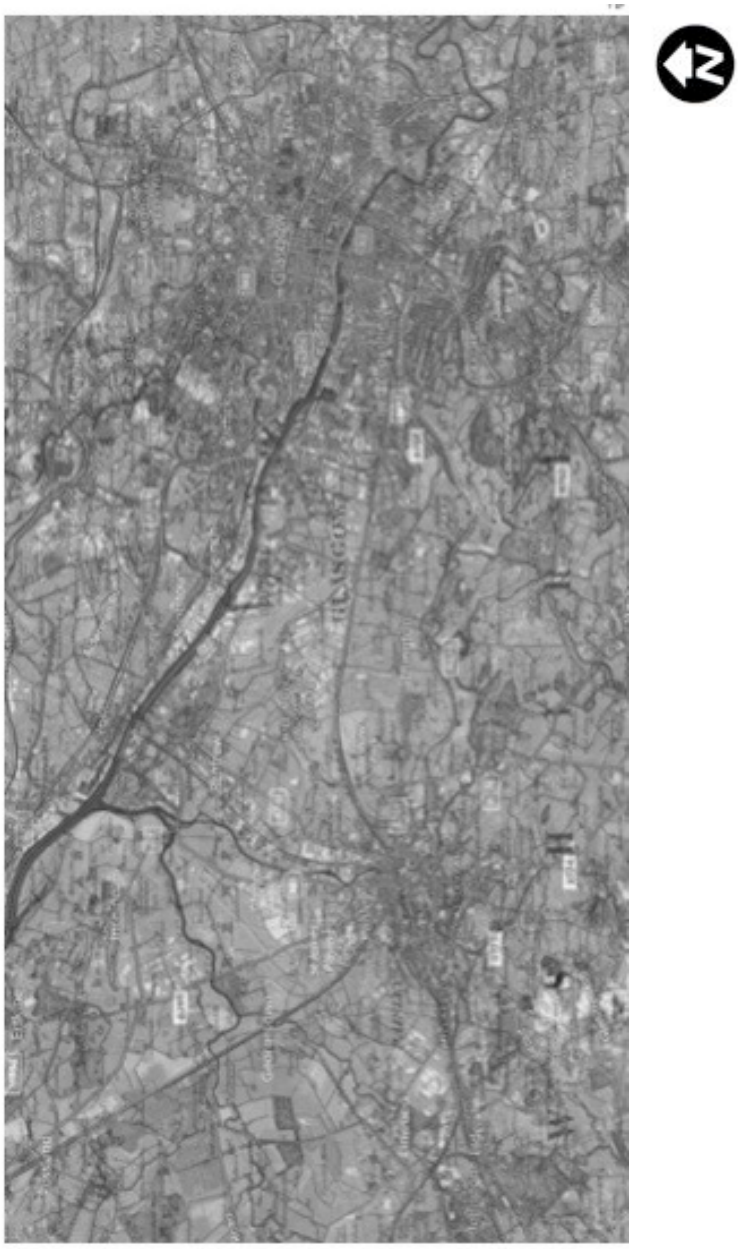


Figure 8.27
Transparency Overlay Map
In the image above, the Paisley Historical Map – 1885-1900
was overlaid upon the 2013 Orthophoto Satellite Map (Bing Maps).
This technique, with fully controllable opacity measures, quickly illustrated
choral spatial development and landscape fragmentation.

8.1.4 Visual Analysis Results: Site Visit

Site visits to the PUAs and CAs were carried out twice and included both a visual analysis and photographic documentation of spatial heterogeneity, GS diversity and edge effect. (See Figure Image Groups 8.28 and 8.29)



Figure Image Groups 8.28
Vantaa, Finland Case Study Area
Site Visit Photographs - Selected
Source: Author



Figure Image Groups 8.29
Paisley, Scotland Case Study Area
Site Visit Photographs - Selected
Source: Author

8.1.5 Landscape Fragmentation and Green Structure Characteristics Visual Analysis Summary

The visual analysis instruments concluded and confirmed that both PURs and CAs as well as their GS exhibited distinct spatial heterogeneity, GS diversity and edge effects. They provided not only an overview of the landscape's GS distribution and composition, but their diversity of including physical characteristics such as size, shape, edge conditions, composition and management as well as a diversity of GS types or typologies - parks, sports facilities, playgrounds, gardens, plazas, etc. and varying edge conditions and disturbances such as long / minimal, tall / short, multiple / few, dense / open, and others.

8.2 Case Study Geospatial Analysis of Landscape Fragmentation and Green Structure Characteristics

This section presents and discusses the results of the spatial landscape analysis foucssing on the landscape fragmentation and GS characteristics.

8.2.1 Geospatial Analysis Results: CORINE Land Cover

The land cover analysis examined the physical characteristics of the CAs and larger region through the use of GIS-based land cover data; this served as an efficient and effective means to illustrate their spatial morphology, particularly urbanisation characteristics and aspects of landscape fragmentation within their GS.

The overall land cover maps (See Figures 8.30 thru 8.33) were primarily utilised to visually and quantitatively assess spatial heterogeneity and landscape fragmentation with withih the CAs. The second set of land cover maps (See Figures 8.34 thru 8.37) focused on the GS characteristics.

The Level I land cover data illustrated overall spatial heterogeneity while the Level II land cover data illustrated GS diversity. Both PURs and CAs exhibited distinct edge effect.

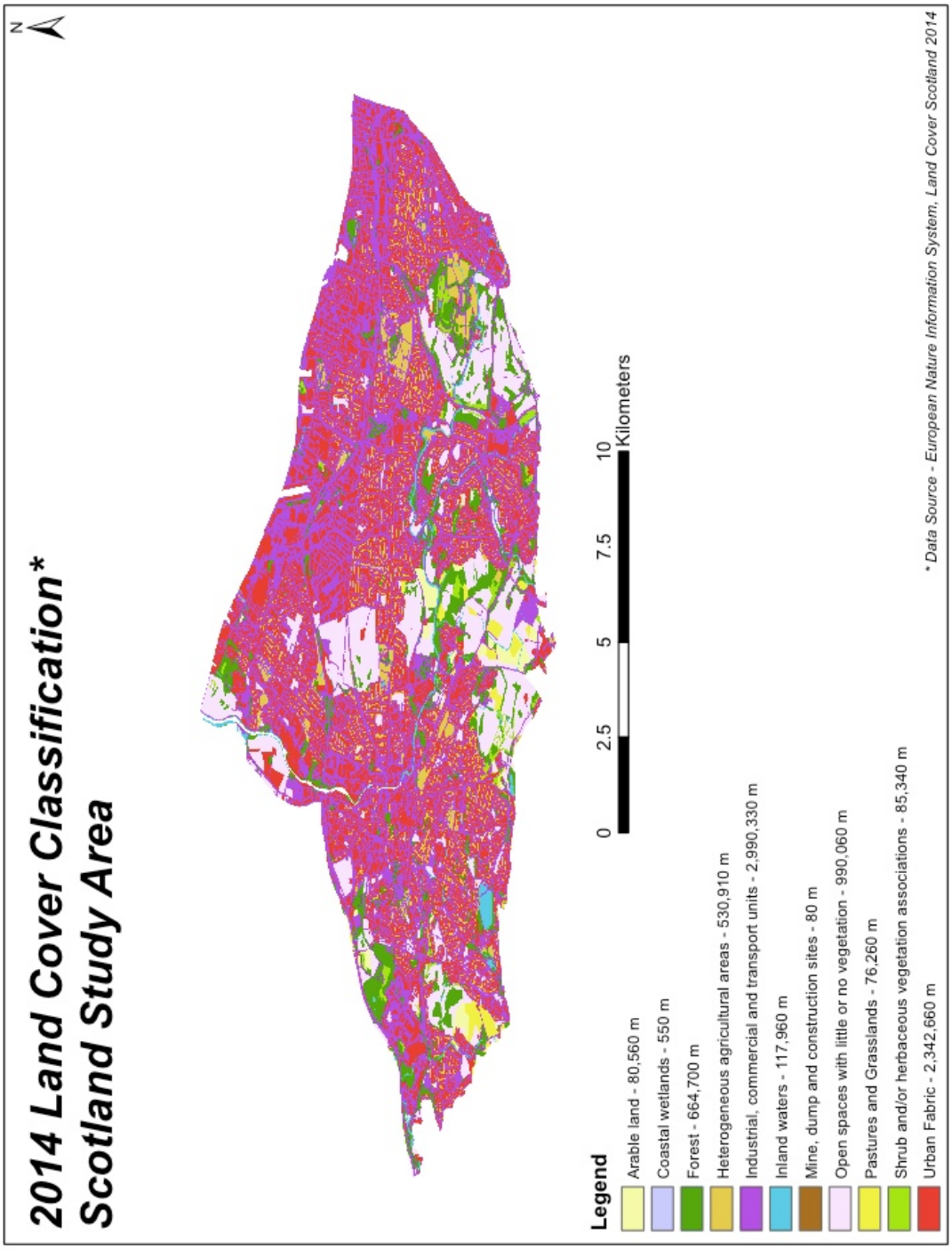


Figure 8.30
Land Cover Map
Class Level 1
Paisley Case Study Area
Source: European Nature Information System, Land Cover Scotland 2014

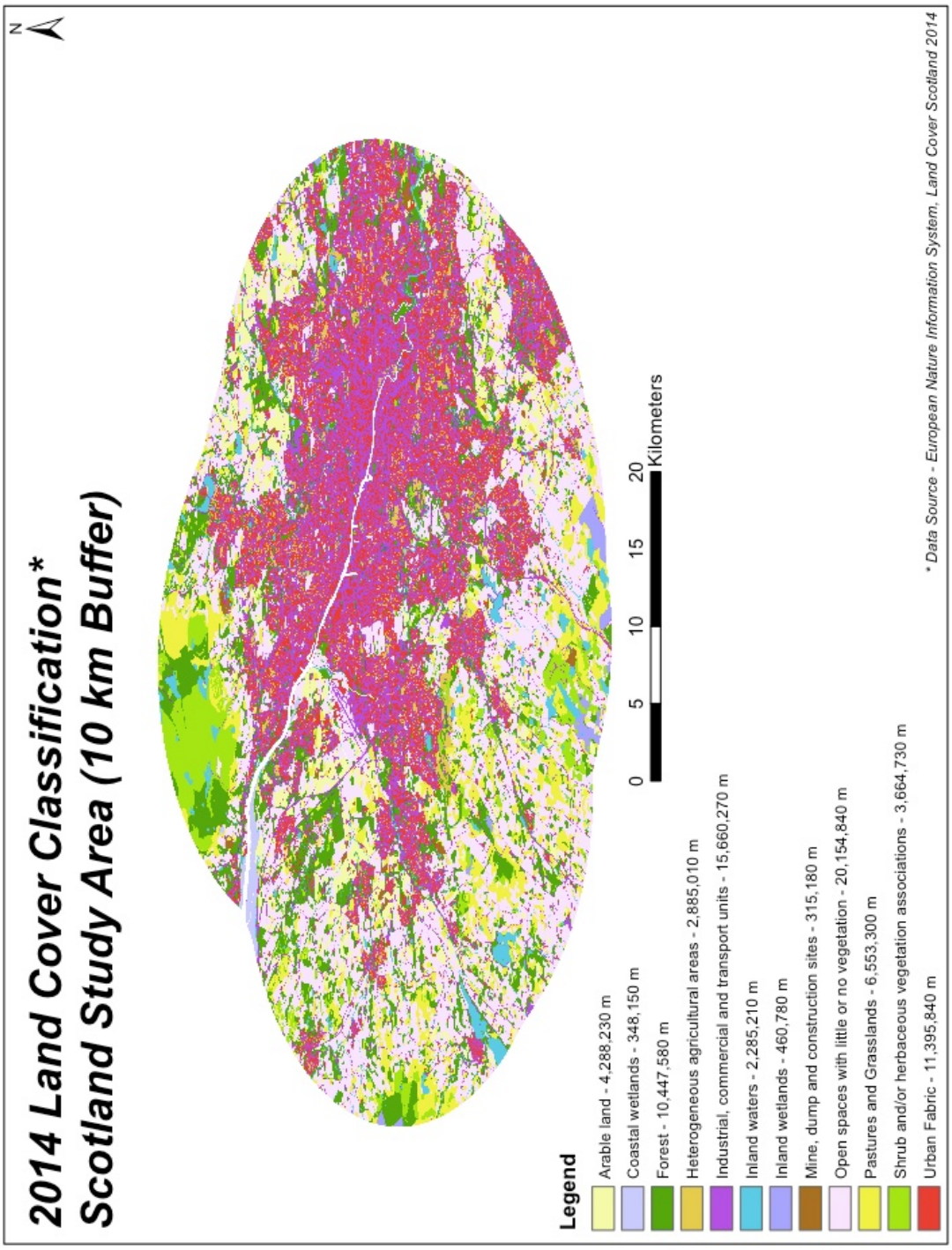


Figure 8.31
Land Cover Map
Paisley Case Study Area 10 km Extension- Class Level 2
Source: European Nature Information System, Land Cover Scotland 2014

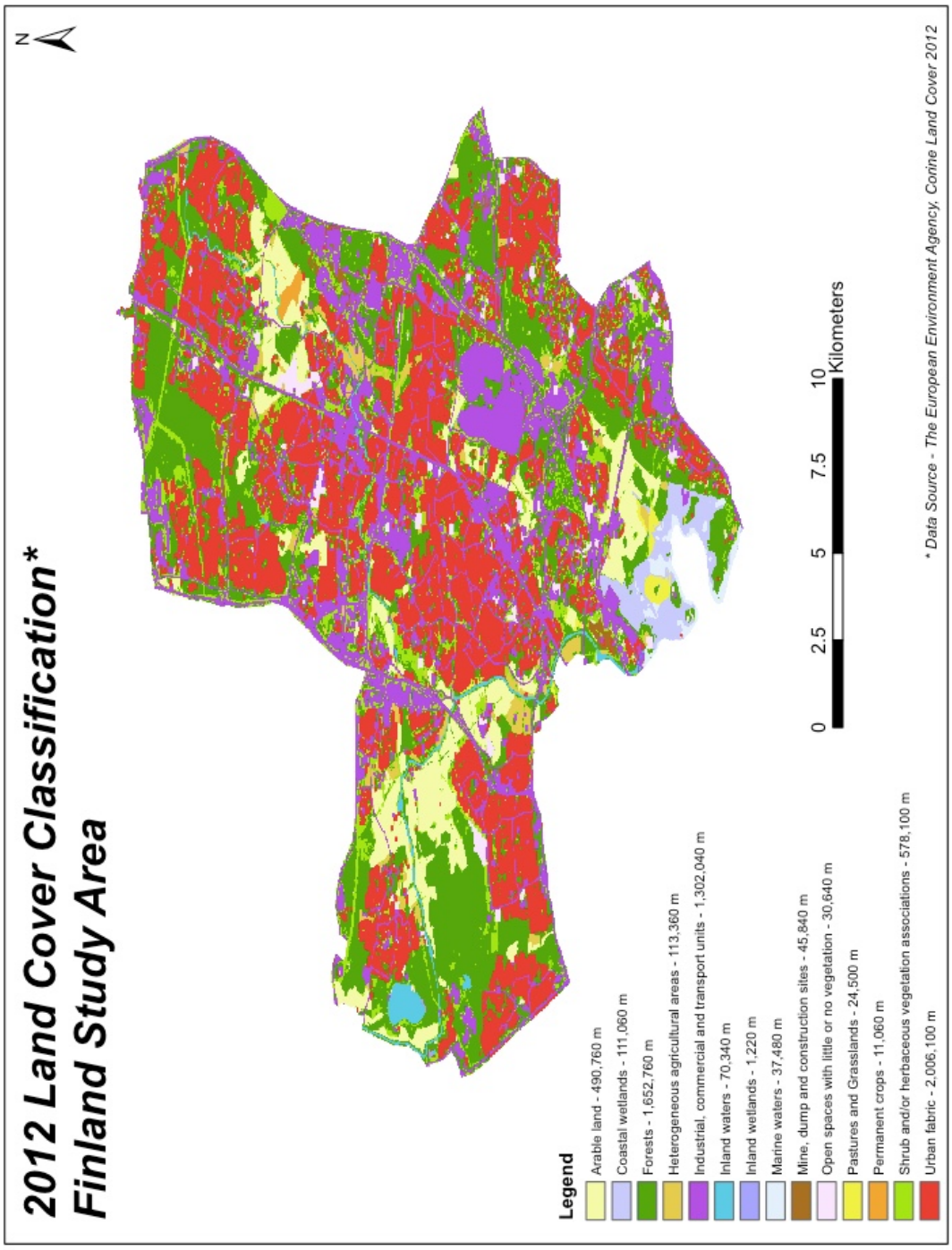


Figure 8.32
Land Cover Map
Class Level 1
Vantaa Case Study Area
Source: The European Environment Agency, CORRINE Land Cover 2012

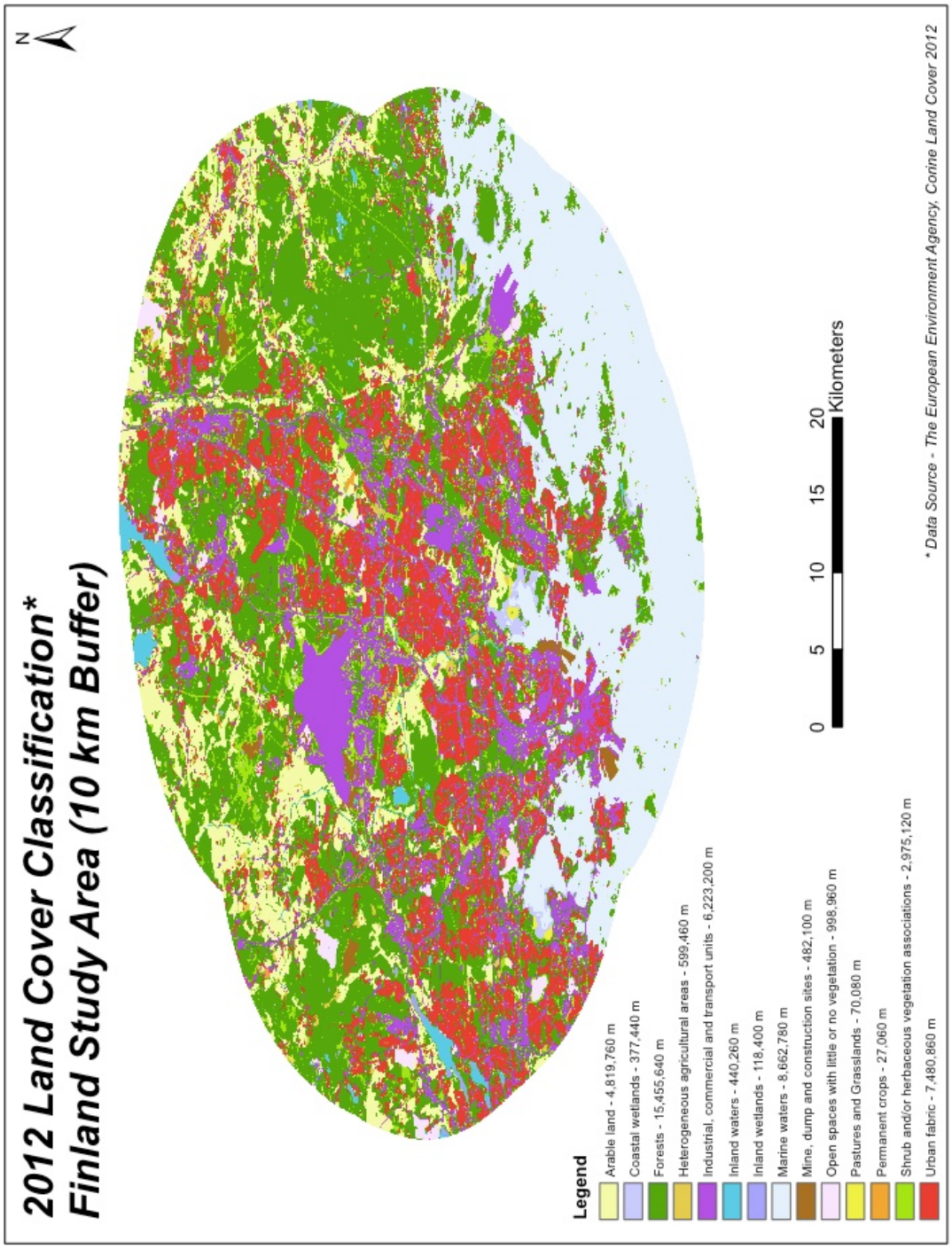


Figure 8.33
Land Cover Map
Vantaa Case Study Area 10 km Extension- Class Level 2
Source: The European Environment Agency, CORRINE Land Cover 2012

In order to specifically assess GS fragmentation and spatial heterogeneity, the land cover's GIS data was re-coded. Appendix 3 provides a summary of this recoding. The land cover analysis at both Class Level I and Class Level II provided important qualitative and quantitative information on both the levels of urbanisation and GS characterisation within the CAs.

The following GS Land Cover acronyms will be utilised:

Shrub and/or Herbaceous Vegetation (SHV);

Forests (F);

Open Space (OS);

Permanent Crops (PC);

Arable Land (AL);

Pastures and Grasslands (PAG);

Heterogeneous Agriculture Areas (HAG);

Shrub and/or Herbaceous Vegetation (SHV).

8.2.1.1 Case Study Area #1: Paisley and the Greater Glasgow Urban Region, Scotland - CORINE Land Cover Analysis Results

This section's Figures and Tables provide the land cover maps and metrics for the overall land cover statistics specific to GS within the Paisley, Scotland CA.

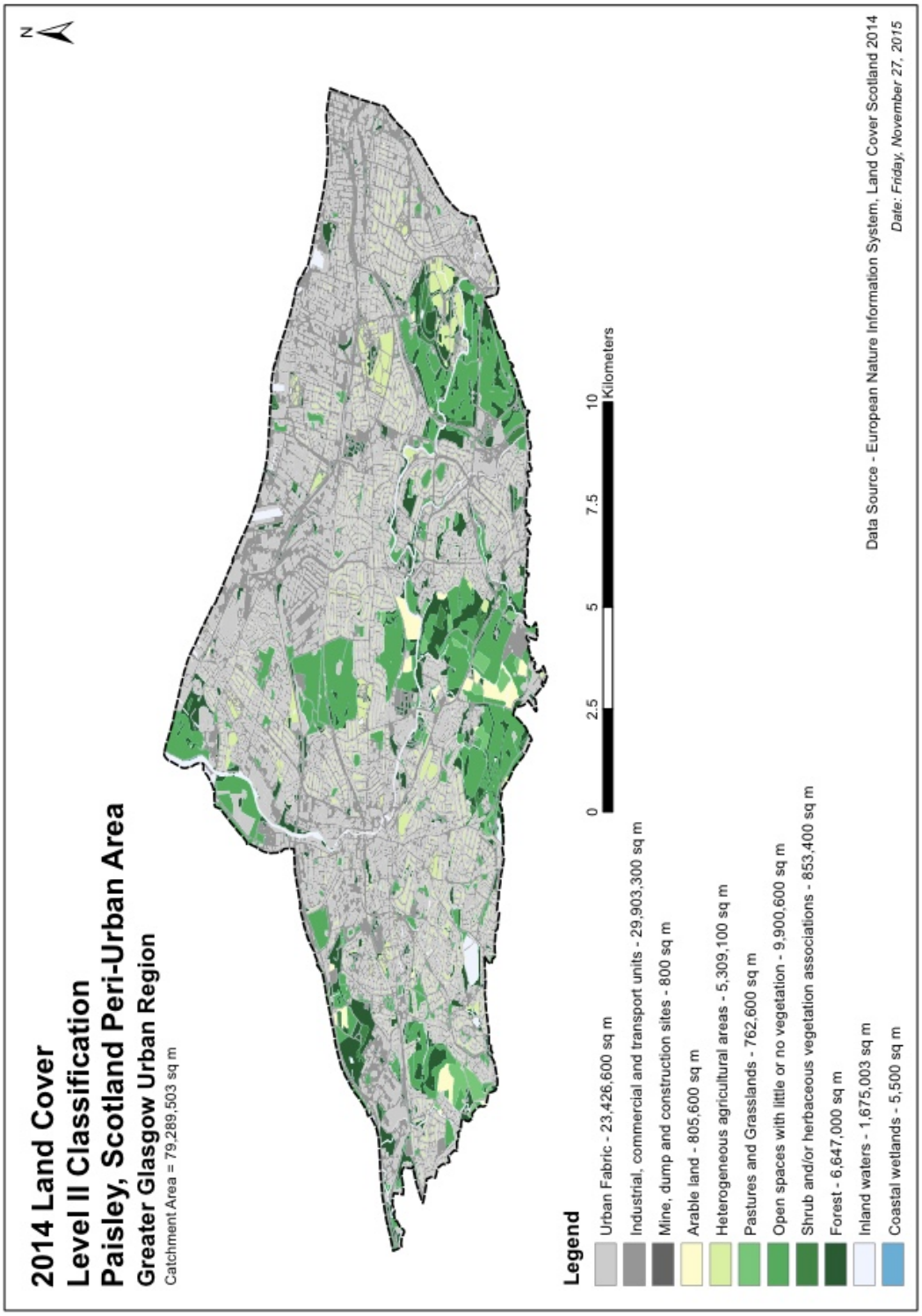


Figure 8.34
Paisley, Scotland Case Study Area - Level II CORINE Land Cover
79,289,503 sq m
77,609,000 sq m total land area

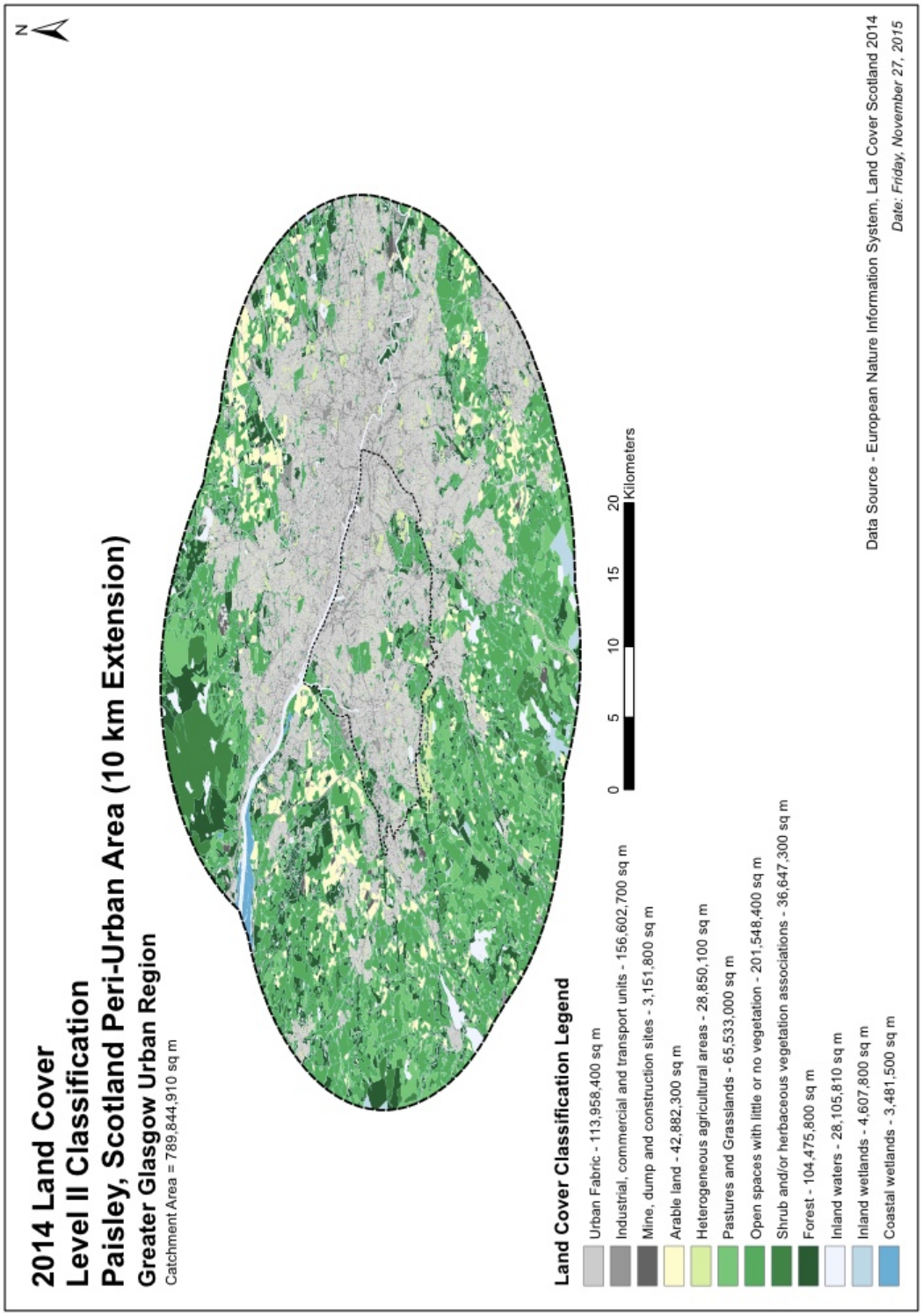


Figure 8.35
Paisley, Scotland Case Study Area (10 km Extension)
Level II CORINE Land Cover
789,844,910 sq m
753,649,800 sq m total land area

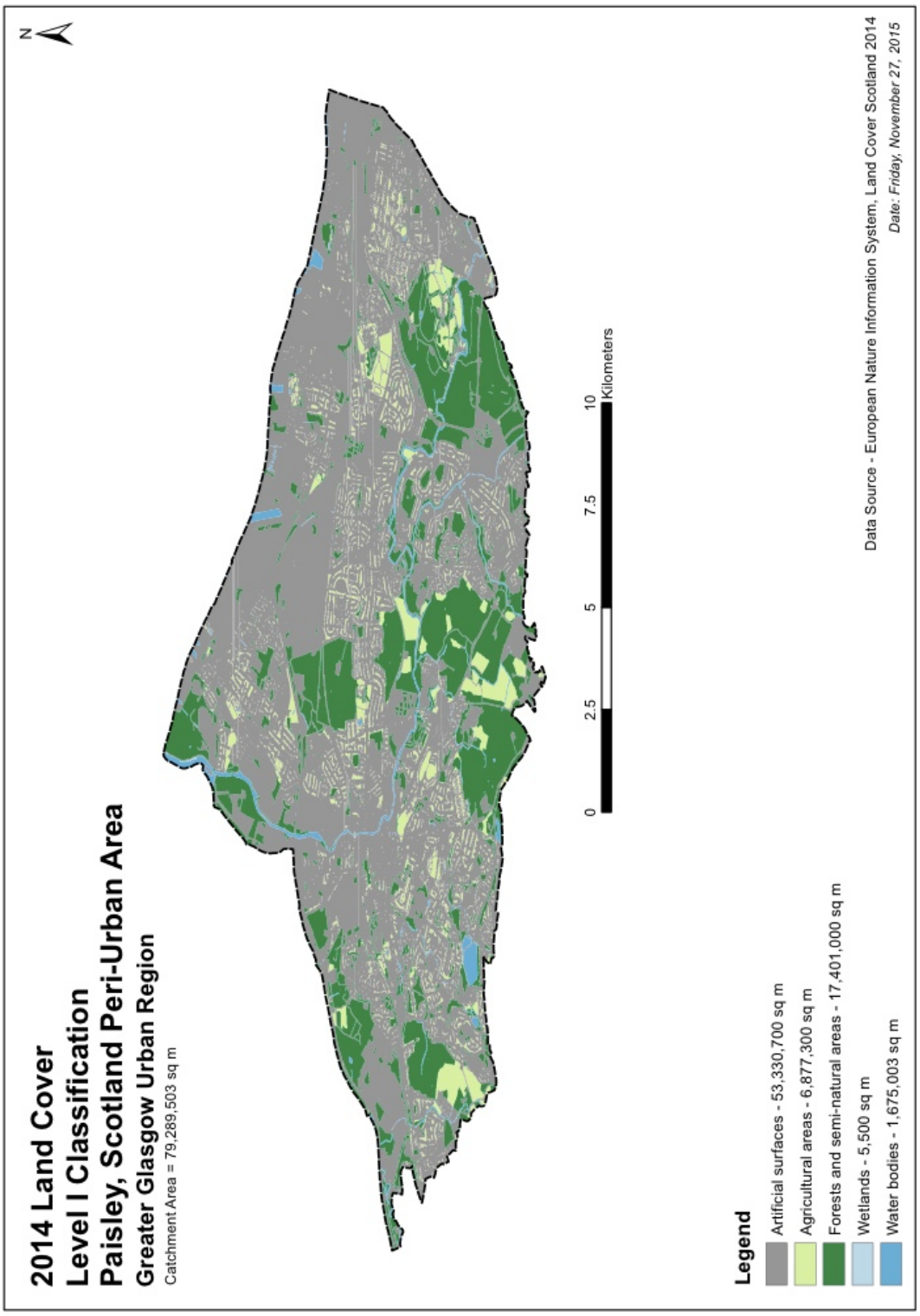


Figure 8.36
Paisley, Scotland Case Study Area
Level I CORINE Land Cover

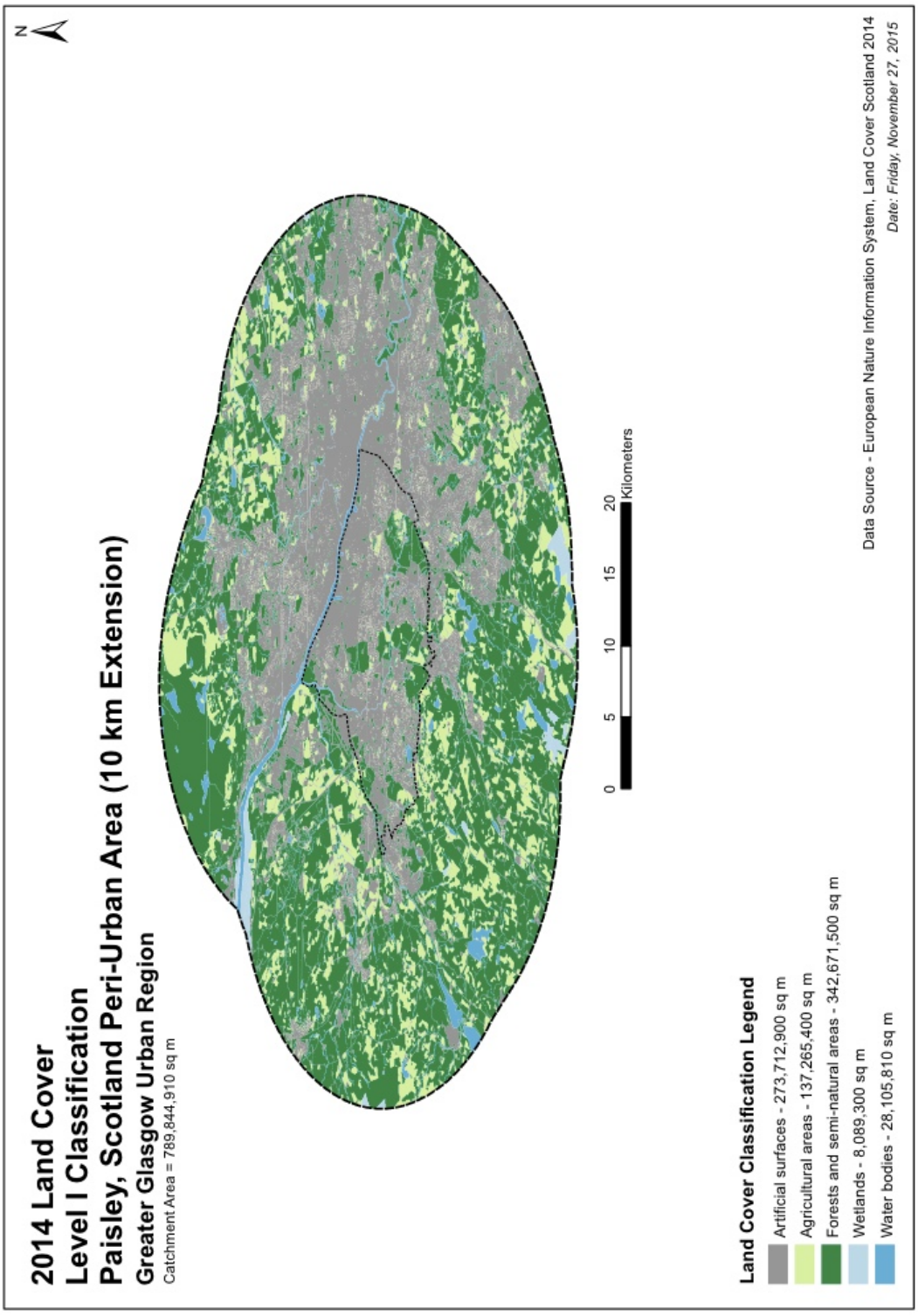


Figure 8.37
Paisley, Scotland Case Study Area (10 km Extension)
Level I CORINE Land Cover

Land Cover Category - Area
Urban Fabric - 23,426,600 sq m
Industrial, commercial and transport units - 29,903,300 sq m
Mine, dump and construction sites - 800 sq m
Arable land - 805,600 sq m
Heterogeneous agricultural areas - 5,309,100 sq m
Pastures and Grasslands - 762,600 sq m
Open spaces with little or no vegetation - 9,900,600 sq m
Shrub and/or herbaceous vegetation associations - 853,400 sq m
Forest - 6,647,000 sq m
Inland waters - 1,675,003 sq m
Coastal wetlands - 5,500 sq m

Figure 8.38
Paisley, Scotland Case Study Area - Level II CORINE Land Cover

Land Cover Category - Area
Urban Fabric - 113,958,400 sq m
Industrial, commercial and transport units - 156,602,700 sq m
Mine, dump and construction sites - 3,151,800 sq m
Arable land - 42,882,300 sq m
Heterogeneous agricultural areas - 28,850,100 sq m
Pastures and Grasslands - 65,533,000 sq m
Open spaces with little or no vegetation - 201,548,400 sq m
Shrub and/or herbaceous vegetation associations - 36,647,300 sq m
Forest - 104,475,800 sq m
Inland waters - 28,105,810 sq m
Inland wetlands - 4,607,800 sq m
Coastal wetlands - 3,481,500 sq m

Figure 8.39
Paisley, Scotland Case Study Area (10 km Extension)
Level II CORINE Land Cover

Land Cover Category - Area
Artificial surfaces - 53,330,700 sq m
Agricultural areas - 6,877,300 sq m
Forests and semi-natural areas - 17,401,000 sq m
Wetlands - 5,500 sq m
Water bodies - 1,675,003 sq m

Figure 8.40
Paisley, Scotland Case Study Area- Level I CORINE Land Cover

Land Cover Category - Area
Artificial surfaces - 273,712,900 sq m
Agricultural areas - 137,265,400 sq m
Forests and semi-natural areas - 342,671,500 sq m
Wetlands - 8,089,300 sq m
Water bodies - 28,105,810 sq m

Figure 8.41
Paisley, Scotland Case Study Area (10 km Extension)
Level I CORINE Land Cover

Summary of Land Cover Data

Artificial Surfaces

The 'Artificial surfaces' Level I Land Cover is 273,712,900 sqm for the CA's 10km Extension and 53,330,700 sqm for the CA. These totals are 36.3% and 68.7%, respectively, for the total land areas (See Figure 8.42). These land cover percentages illustrate that the Paisley, Scotland conurbation is primarily urbanised and the larger PUA (i.e. the 10km extension) is much less urbanised and developed. These land cover ratios support, spatially, the typical urban-rural transect (See Figure 3.2) from the urban core to the peri-urban to the rural hinterland; illustrating a gradual decrease in impermeable surfaces and a gradual increase in non-urban land covers.

	Case Study Area	Case Study Area - 10km Extension
Artificial Surfaces	36.30%	68.70%

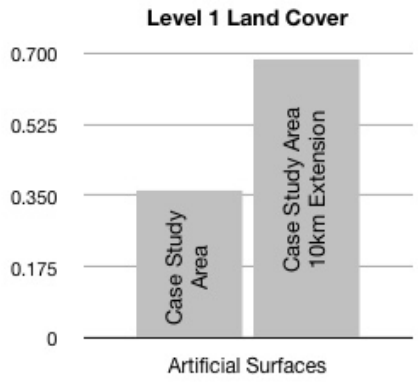


Figure 8.42
Paisley, Scotland Case Study Area
Artificial Surfaces Comparison
Level I CORINE Land Cover

Green Structure

From the data illustrated wihthin Figure 8.43, the total Level I GS area for the CA is 31.3% and 63.7% for the 10km (Total land area *minus* water-based land cover *minus* artificial surfaces). Of note, adding the blue structures such as 'Wetlands' and 'Water Bodies' to the GS total, often considered an open space (See Chapter 2), provided an insignificant increase in GS land cover. In this context, most of the blue structure area increase occurred within the River Clyde.

	Case Study Area	Case Study Area - 10km Extension
Green Structure	31.30%	63.70%

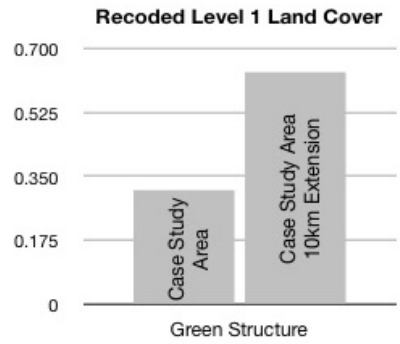


Figure 8.43
Paisley, Scotland Case Study Area
Green Structure Comparison
Level I CORINE Land Cover

For the Class Level II data, the composition of the CA is dominated by both the Urban Fabric (UF), Open Spaces (OS) and Industrial, Commercial and Transport (ICT) units. However, the 10km landscape is most prevalent with OS and ICT units. This shows a more densely urbanised CA than the 10km. Within the CA, the highest number of patches within the GS classification is HAG)(n=3100) followed by F) (n=950); within the 10km, these are 16,500 and 5,713 respectively.

Figure 8.44 illustrates the GS comparison of the CA and 10km. Of note is the high 'Open spaces with little or no vegetation'; it occupies 9,900,600 sq m or 12.8% of the total land area within the CA and 201,548,400 sq m or 26.8% total land area for the 10km. This total by itself is almost ¾ or 73.6% of the total urbanised land cover (i.e. Artificial Surfaces -273,712,900 sqm) within the same area. In the CORINE Land Cover nomenclature, this recoding is also considered to be 'Beaches, dunes, and sand plains', 'Bare rock', and 'Sparsely vegetated areas'. Though the recoding did account for some of this classification's significant total area, a visual examination confirmed that the additional GS included within this nomenclature are primarily non-active agricultural lands. Though these are often referred to as grasslands or future agriculture areas (i.e. crop rotation), visually and physically they appear as non-active agriculture lands. Regardless, this Level II land cover type was encapsulated within the 'Forests and semi-natural areas' land cover in the Level I classification.

		Case Study Area	Case Study Area - 10km Extension
Arable land	AL	1%	5.7%
Heterogeneous agricultural areas	AG	6.8%	3.8%
Pastures and Grasslands	P&G	0.1%	8.8%
Open spaces with little or no vegetation	OS	12.8%	26.8%
Shrub and/or herbaceous vegetation associations	Shrub	1.1%	4.9%
Forest	Forest	8.6%	13.9%

Figure 8.44
Paisley, Scotland Case Study Area
Green Structure Comparison
Level II CORINE Land Cover

8.2.1.2 Case Study Area #2: Helsinki and the Helsinki Urban Region, Finland - CORINE Landcover Analysis Results

This section's Figures and Tables provide the land cover maps and metrics for the overall land cover statistics specific to GS within the Vantaa, Finland CA.

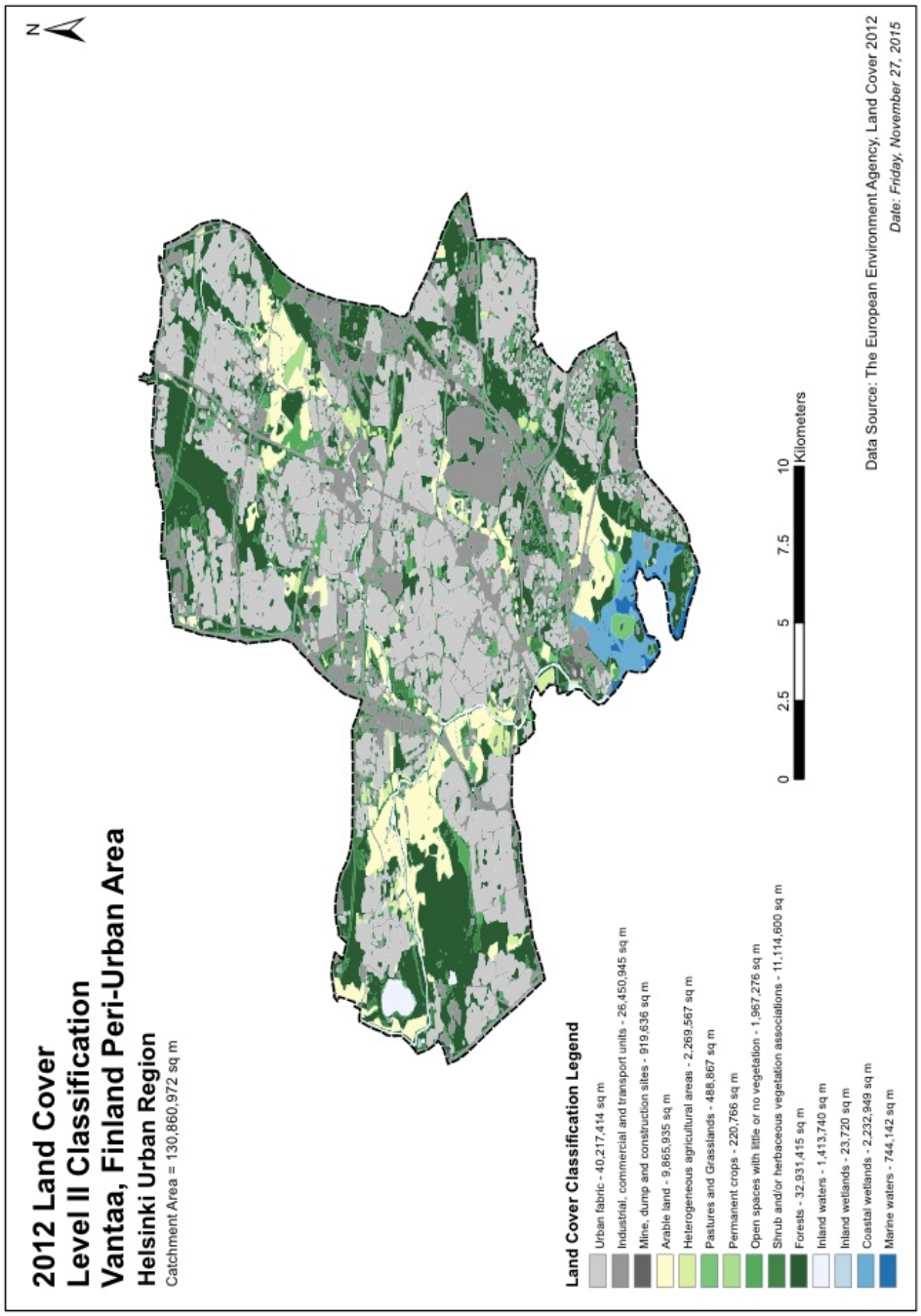


Figure 8.45
Vantaa, Finland Case Study Area
Level II CORINE Land Cover

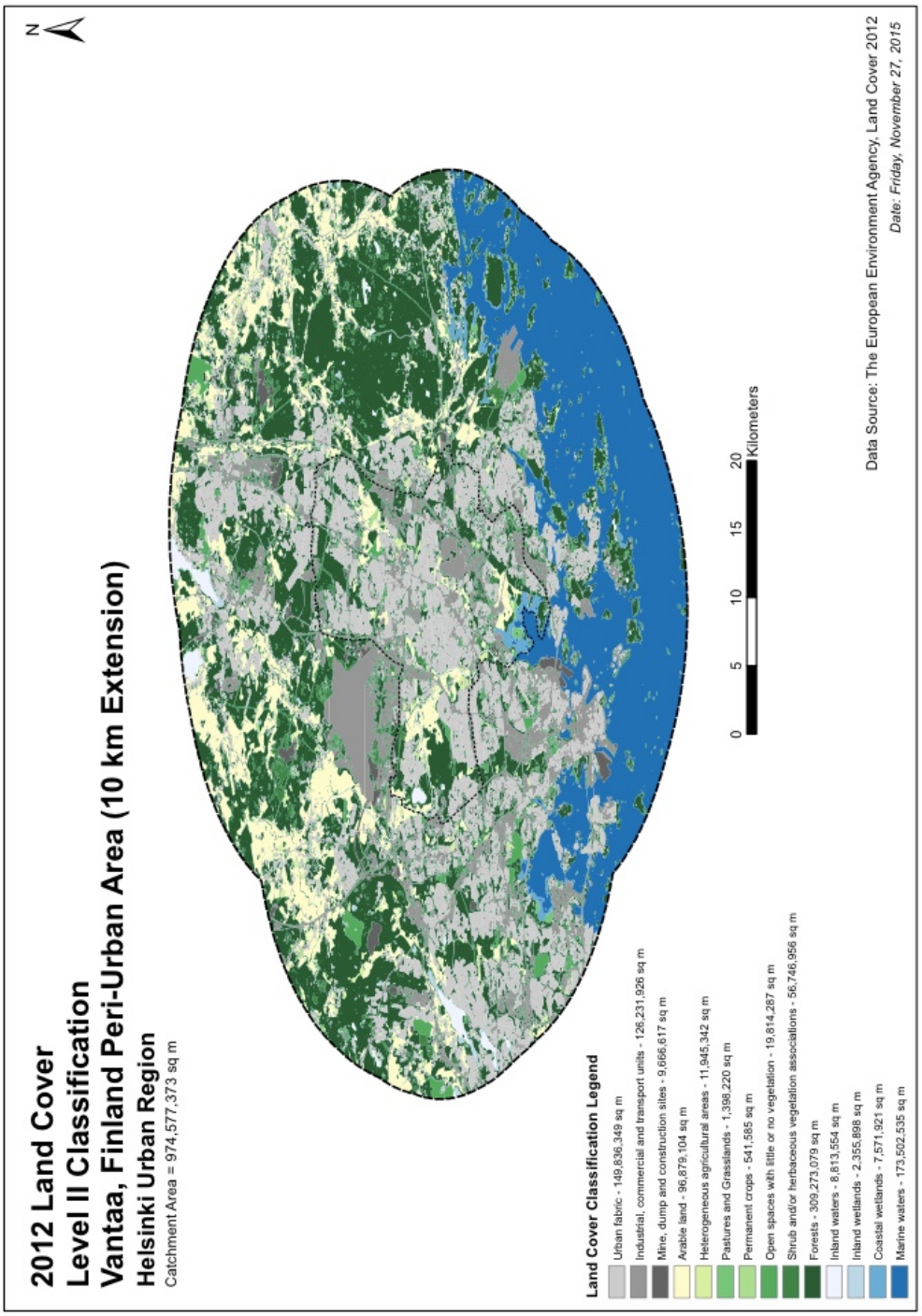


Figure 8.46
Vantaa, Finland Case Study Area (10 km Extension)
Level II CORINE Land Cover

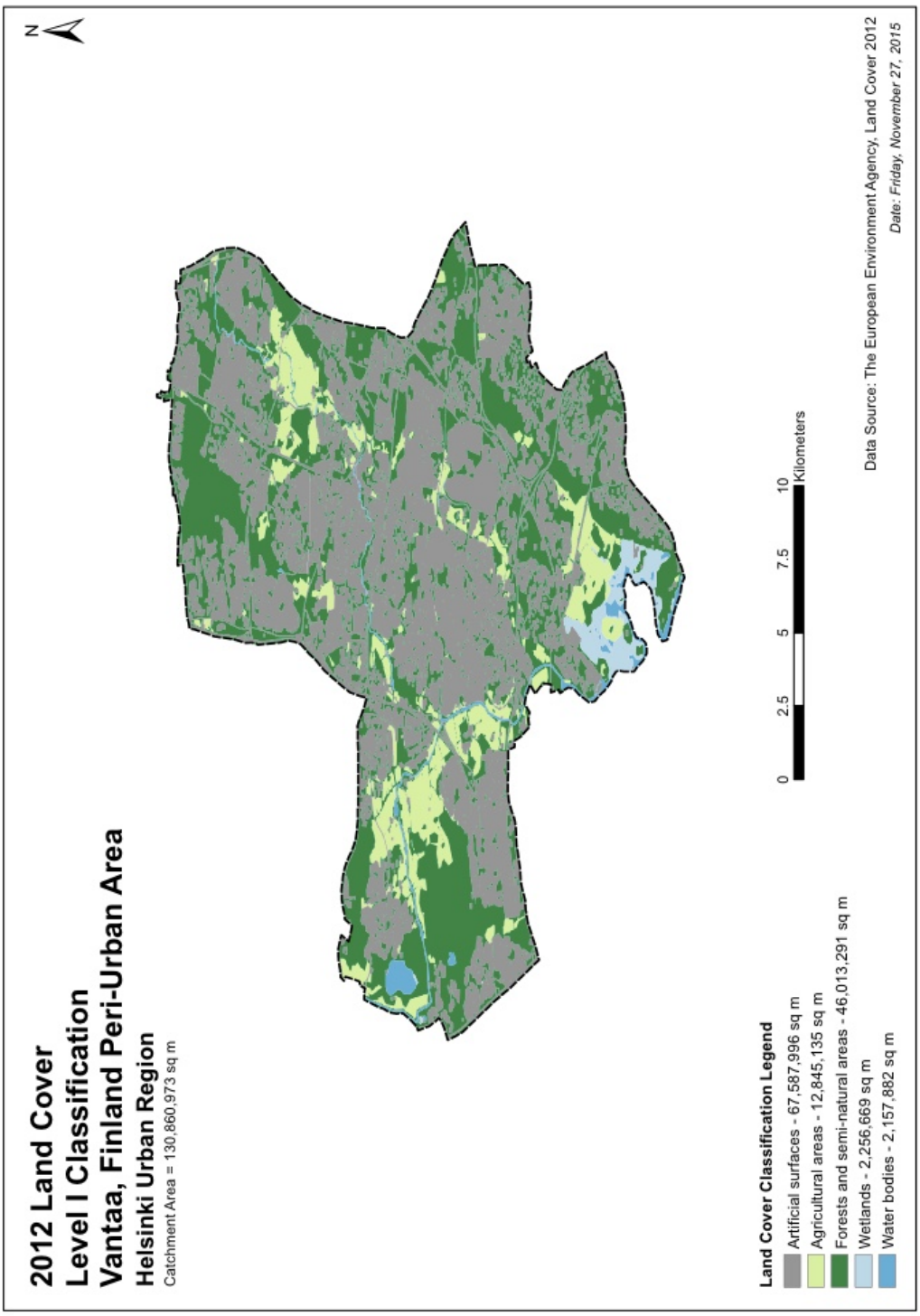


Figure 8.47
Vantaa, Finland Case Study Area
Level I CORINE Land Cover

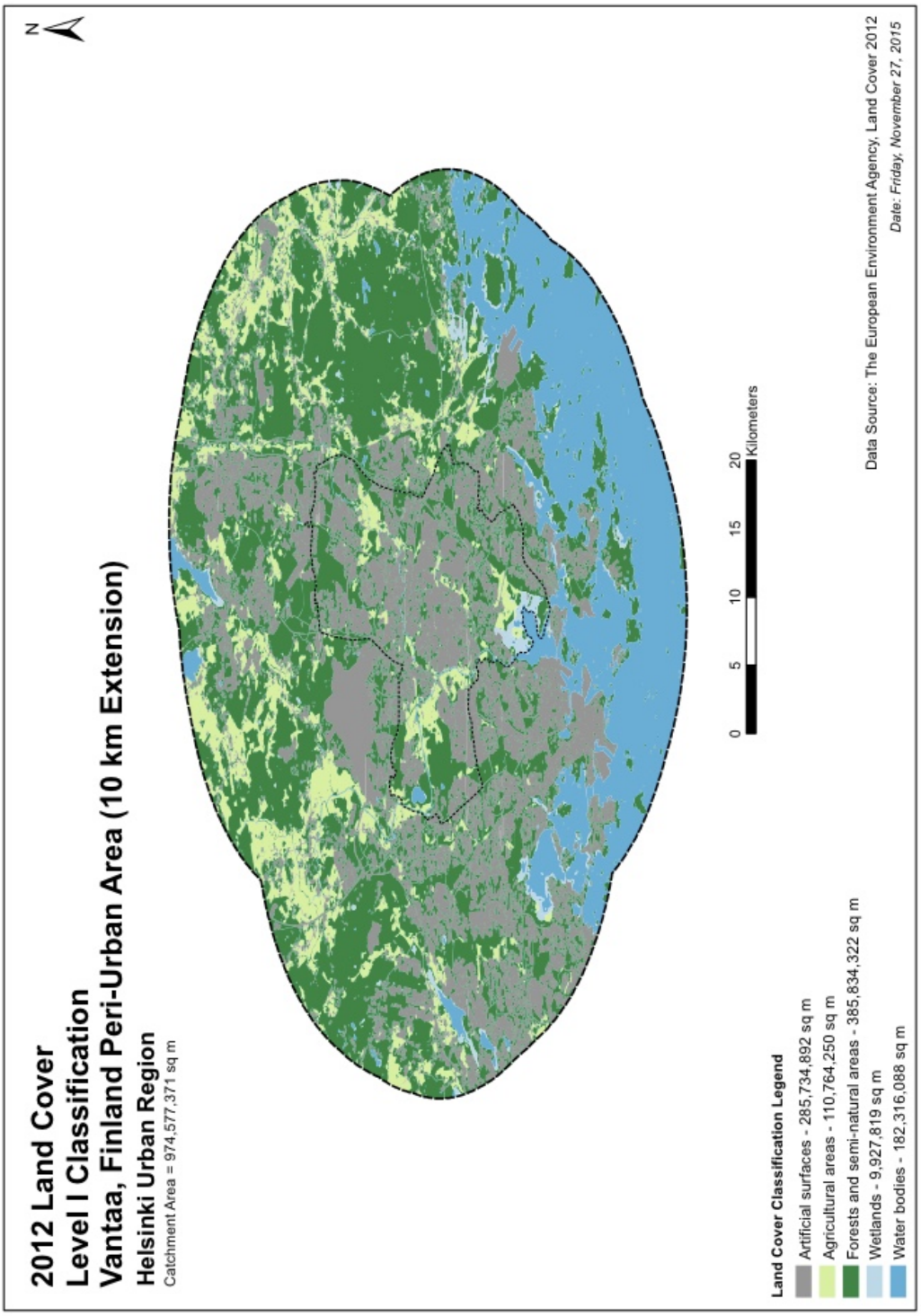


Figure 8.48a
Vantaa, Finland Case Study Area (10 km Extension)
Level I CORINE Land Cover

Land Cover Data
Urban fabric - 40,217,414 sq m
Industrial, commercial and transport units - 26,450,945 sq m
Mine, dump and construction sites - 919,636 sq m
Arable land - 9,865,935 sq m
Heterogeneous agricultural areas - 2,269,567 sq m
Pastures and Grasslands - 488,867 sq m
Permanent crops - 220,766 sq m
Open spaces with little or no vegetation - 1,967,276 sq m
Shrub and/or herbaceous vegetation associations - 11,114,600 sq m
Forests - 32,931,415 sq m
Inland waters - 1,413,740 sq m
Inland wetlands - 23,720 sq m
Coastal wetlands - 2,232,949 sq m
Marine waters - 744,142 sq m

Figure 8.48b
Vantaa, Finland Case Study Area - Level II CORINE Land Cover

Land Cover Data
Urban fabric - 149,836,349 sq m
Industrial, commercial and transport units - 126,231,926 sq m
Mine, dump and construction sites - 9,666,617 sq m
Arable land - 96,879,104 sq m
Heterogeneous agricultural areas - 11,945,342 sq m
Pastures and Grasslands - 1,398,220 sq m
Permanent crops - 541,585 sq m
Open spaces with little or no vegetation - 19,814,287 sq m
Shrub and/or herbaceous vegetation associations - 56,746,956 sq m
Forests - 309,273,079 sq m
Inland waters - 8,813,554 sq m
Inland wetlands - 2,355,898 sq m
Coastal wetlands - 7,571,921 sq m
Marine waters - 173,502,535 sq m

Figure 8.49
Vantaa, Finland Case Study Area (10 km Extension) - Level II CORINE Land Cover

Land Cover Data
Artificial surfaces - 67,587,996 sq m
Agricultural areas - 12,845,135 sq m
Forests and semi-natural areas - 46,013,291 sq m
Wetlands - 2,256,669 sq m
Water bodies - 2,157,882 sq m

Figure 8.50
Vantaa, Finland Case Study Area - Level I CORINE Land Cover

Land Cover Data
Artificial surfaces - 285,734,892 sq m
Agricultural areas - 110,764,250 sq m
Forests and semi-natural areas - 385,834,322 sq m
Wetlands - 9,927,819 sq m
Water bodies - 182,316,088 sq m

Figure 8.51
Vantaa, Finland Case Study Area (10 km Extension)
Level I CORINE Land Cover

Summary of Land Cover Data

Artificial Surfaces

The ‘Artificial surfaces’ Level I Land Cover is 285,734,892 sqm for the CA’s 10km and 67,587,996 sqm for the CA. These totals are 36.3% and 53.5%, respectively, for the total land areas (See Figure 8.52). These land cover percentages illustrate that the Vantaa, Finland conurbation is primarily urbanised and the larger PUA or 10km extension is much less urbanised and developed.

	Case Study Area	Case Study Area - 10km Extension
Artificial Surfaces	36.30%	53.50%

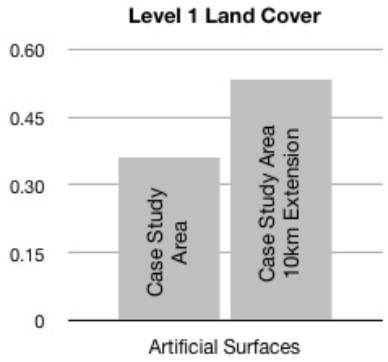


Figure 8.52
Vantaa, Finland Case Study Area
Artificial Surfaces Comparison
Level I CORINE Land Cover

Green Structure

From the data illustrate in Figure 8.53, the total Level I GS area for the CA is 46.1% and 63.5% for the 10km (Total land area *minus* water-based land cover *minus* artificial surfaces). These land cover percentages illustrate that the Vantaa, Finland PUA is primarily urbanised with a low percentage of GS and the larger 10km has many more GS. Of note, adding the Level I water based land covers such as ‘Wetlands’ and ‘Water bodies’ to the GS land cover provided a somewhat significant increase (6.5%). In this context, most of the blue structure area increase occurred within the Gulf of Finland and the various bays adjacent to the land area.

	Case Study Area	Case Study Area - 10km Extension
Green Structure	46.10%	63.50%

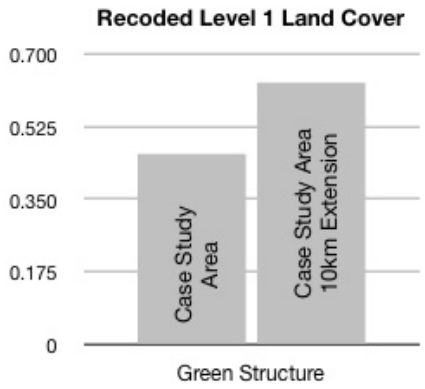


Figure 8.53
Vantaa, Finland Case Study Area
Green Structure Comparison
Level I CORINE Land Cover

For the Class Level II data, the composition of the CA has three significant Classes, UF, F, and IC units respectively. However, the 10km landscape is dominated by F (n=31,000ha) followed by UF (15,000ha) and ICT (12,500ha). This shows a more densely forested landscape in the 10k than the CA. Within the CA, the highest number of patches within the GS classification was SHV (n=4700) followed by F (n=3551); within the 10km, these are 26,400 and 16,500 respectively.

Figure 8.46 illustrates the GS comparison of the CA and 10km. Of note is the high 'Forests', it occupies 32,931,415 sqm or 26.0% total land area within the CA and 309,273,079 sqm or 40.0% total land area for the 10km. This is more than 20,000,000 sqm above the total 'Artificial surfaces' within the same area. Clearly, the most prevalent GS landcover in the Vantaa conurbation and PUR is 'Forests'.

		Case Study Area	Case Study Area - 10km Extension
Arable land	AL	8%	12.4%
Heterogeneous agricultural areas	AG	1.8%	3.8%
Pastures and Grasslands	P&G	<.01%	1.6%
Permanent Crops	PC	<.01%	<.01%
Open spaces with little or no vegetation	OS	1.6%	2.5%
Shrub and/or herbaceous vegetation associations	Shrub	8.8%	7.3%
Forest	Forest	26.0%	39.6%

Figure 8.54a
Vantaa, Finland Case Study Area
Green Structure Comparison
Level II CORINE Land Cover

8.2.2 CORINE Land Cover Results Case Study Comparison

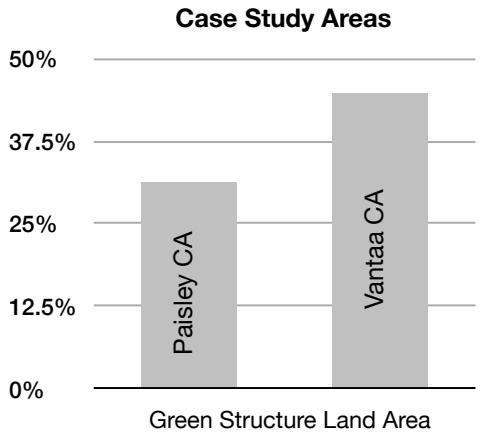
Table 8.1 shows that the Land Area totals within the 10kms are remarkably similar. Though the CAs themselves are not as similar in total area, the other characteristics considered in selection of the CAs were more relevant to this research's objectives. Additionally, it is the spatial analysis (i.e. fragmentation characteristics) within these CAs that is of primary concern to this research, not the overall land area.

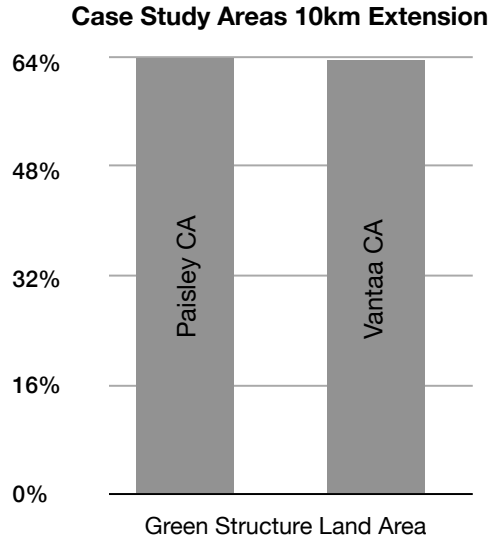
Case Study Area	Total Land Area
Paisley, Scotland	77,609,000 sq m
Paisley, Scotland (10km Extension)	753,649,800 sq m
Vantaa, Helsinki	126,446,422 sq m
Vantaa, Helsinki (10km Extension)	782,333,465 sq m

Table 8.1
Case Study Areas Total Land Area Comparison
Excludes water-based land covers

It should be noted that, although blue structures are considered a spatial entity similar to OS that are not urbanised or artificially surfaced, they are not included in this analysis. The Vantaa 10km had considerable water land cover areas (i.e. blue structures) that were removed from the calculations, hence the more congruous total.

Figure 8.54 illustrates an important spatial characteristic of the CA's GS - both GS totals within the 10kms are remarkably similar; however within the CAs themselves –the more urbanised areas of study – GS totals vary.





	Case Study Area Green Structure	Case Study Area - 10km Extension Green Structure
Paisley, Scotland	31.3%	63.7%
Vantaa, Finland	45.0%	63.5%

Case Study Area	Total GS Area	Total %
Paisley, Scotland	24,278,300 sq m	31.3%
Paisley, Scotland (10km Extension)	479,936,900 sq m	63.7%
Vantaa, Helsinki	58,858,426 sq m	45.0%
Vantaa, Helsinki (10km Extension)	496,598,574 sq m	63.5%

Figure 8.54b
Case Study Areas Total Green Structure Area Comparison
Excludes water-based land covers

8.3 Landscape Fragmentation and Green Structure Characteristics Geospatial Analysis Results – FRAGSTATS Spatial Analysis Tool Results

The FRAGSTAT analysis operationalised three separate analyses for each of the two spatial contexts – the CA and the CA 10km extension (10km) - for each case study region. These analyses were Binary (i.e. Green Structure vs. Artificial Surfaces), Class Level I, and Class Level II completed at Landscape Levels and Class or Patch Levels and provided comprehensive results. For example, Landscape Level analyses focus on composition and configuration of the landscape pattern whereas Class Level analyses provide patch-based similarity characteristics at a more detailed extent (e.g. degree of connectivity, degree of proximity, etc.). The complete FRAGSTATS analysis metadata output is located within Appendix 4.

In summary, there were two different aspects of fragmentation analysed (for both the smaller CA and the larger 10km region): 1. The overall or landscape level fragmentation (binary = all artificial surface patches vs all green structure patches) and 2. the green space fragmentation (Class II green space patches per CORINE).

The Overall Landscape Context: For ALL patches (GS and Impermeable Surfaces), the FRAGSTAT and Landscape Analysis illustrated that the Paisley PolyPUR (10km) and Case Study Area (CA) is, overall, comparatively, more fragmented than the Vantaa PolyPUR (10 km) and Case Study Area (CA).

The Overall Landscape - Green Space Context: Green space fragmentation is less within each study area's PolyPur (10km) when compared to their Case Study Area (CA).

The Overall Green Space Context: For ALL Green Space patches (GS Classes only), the FRAGSTAT and Landscape Analysis illustrated that the Paisley PolyPUR (10km) and Case Study Area (CA) GS is, overall, comparatively, more fragmented than the Vantaa PolyPUR (10 km) and Case Study Area (CA) GS.

The Specific Green Space Context: For ALL Green Space patches (GS Classes only) within each CA (Not 10km):

- Vantaa's Forest GS patches are more fragmented, overall, generally, than Paisley's Forests GS patches. -

- Vantaa's Arable Land GS patches are more fragmented, overall, generally, than Paisley's Arable Land GS patches.
- Paisley's Open Space GS patches are more fragmented, overall, generally, than Vantaa's Open Space GS patches.
- Vantaa's Permanent Crop GS patches are more fragmented, overall, generally, than Paisley's Permanent Crop GS patches.

The important conclusion from this and other data is that Vantaa has some important GS fragmentation metrics beyond the results which puts Vantaa's CA GS spatial context into an important perspective: Even though Vantaa's Forest and Arable GS patches are Vantaa's two most fragmented GS classes (Table 8.6), when reviewing other metrics, results illustrate a higher proximity and less separated GS when compared to Paisley.

These results thus indicate a more distinct green structure overall, though still within Vantaa's CA's overall fragmented context. Thus, within Vantaa's CA more fragmented Forest and Arable Land GS context (when compared to Paisley), these GS are, however, more interconnected and contiguous to one another and other GS than Paisley, indicating a green infrastructure pattern and form to its fragmented GS which the Paisley CA's GS do not exhibit, though less fragmented, overall, generally, compared to Vantaa's GS.

8.3.1 Case Study Area #1: Paisley and the Greater Glasgow Urban Region, Scotland - FRAGSTATS Analysis Results

Case Study Area and 10km Extension, Binary Analysis (Binary = Green Space (1) and Artificial Surfaces (2) for All Classes or Types of Landscape Covers

Size Characteristics

The total number of patches, regardless of class, increased from 3,400 (CA) to 18,000 (10km). The patch density, however, reduced from 42 to 23. This shows that the spatial pattern in the 10km is less spatially fragmented than the CA.

Shape Characteristics

The shape index for the CA, regardless of class, had a mean of 25 vs. the 10km of 52 with a range of 34 vs. 109. These metrics show that the shape of the

individual parcels within the 10km are more complex and more irregular shaped, and also larger shaped overall.

Proximity Characteristics

The Nearest Neighbor range increased from 333m (CA) to 1174m (10km), showing that the context of the landscape and its individual patches proximity or distance to another (center-to-center) increases.

Edge Characteristics

The total number of edges increased from 986,000 in CA to almost 8 million in the 10km. Though the overall land area of analysis increased 10x, the number of edges also grew proportionally.

Case Study Area and 10km Extension, Class Level II Analysis

Most of the metrics processed provided similar results and were repetitive to the Land Cover analysis prior as it uses the same Level II Classes. However, notable FRAGSTATS results occurred.

Size Characteristics

The densest patch type in the CA is HAG (n=39) and within the10km is UF (n=44). Within the area metrics, the configuration of the CA's GS shows OS (n=35) with highest proportion and in the 10km it is Shrub and/or Herbaceous Vegetation (SHV) (n=529). Thus, within the larger 10km context of Paisley, there are, on weighted average to their similar patches, less OS and more SHV areas. However, this is not an empirical total.

In the CA, the GS Class with the largest size range is OS (n=76) and is the same for the 10km (n=1400). Using the edge-depth distance of 10m, the Core Index showed that in the CA and the 10km, the most widely distributed GS Class was OS (CORE_MN=3.07; CORE_MN=6.98).

Shape Characteristics

The most complex shaped (i.e. not regularly shaped) GS is SHV (SHAPE_MN=1.6) in the CA and F (SHAPE_MN=1.5) in the 10km.

Proximity Characteristics

The Proximity Index measures the degree of isolation and fragmentation within the landscape, it considers the size and proximity of all patches whose edges are within a specified search radius (200m). Comparatively, then, the top three GS Classes with the most fragmentation are shown in Table 8.2. Thus, within the larger PUL, there is an increase in SHV fragmentation, whereas the AL becomes less fragmented.

	CA	10km
1.	OS	OS
2.	F	SHV
3.	AL	F

Table 8.2
Paisley, Scotland CA
GS Fragmentation Metrics - Class II
Proximity Index Results

The Similarity Index, which doesn't assess Classes of patches, but rather size and proximity (with same search radius), showed that within the CA, all patches are very similar in size and proximity to one another, however, within the 10km, the HAG were significantly more fragmented (n=155,046) than other GS classes, where the PAG were the least fragmented Class (n=31,465).

The Euclidean Nearest Neighbor Index (ENN), similar to Proximity but looks at similar patches and GS Classes only, showed that in the CA, it was the HAG who were least fragmented – distance wise – to other similar patches (n=52m), with AL (n=362m) and SHV (n=165m) being the most separated from similar patch Classes. In the 10km, it was again the HAG being least separated (n=56m) with AL (n=185m) and SHV (n=157m). Notably, the distances were quite similar, except for the AL, showing that within the larger PUL, AL are, generally, closer to one another.

The most frequently adjacent (PLADJ) and least interspersed (IJI) and physically connected (COHESION) GS Classes were OS, AL, and PAG in the CA but OS, SHV, and AL in the 10km.

Edge Characteristics

Edge wise, the CA showed that the most densely edged GS Classes (Table 8.3) were HAG (n=37), F (n=23), and OS (n=16) and the least were PAG (n=1.4) and AL (n=1.3). In the 10km, these remained relatively the same, however SHV became the least densely edged (n=4.2). The GS Class with the highest total amount (meters) of edges is HAG within the CA (n=586,000m) followed by F (n=368,000m). Within he 10km, this doesn't change significantly (F: n=4,050,000m; HAG: n=3,800,000m). The Edge Contrast Index (ECON) showed that within both the CA and 10km, regardless length or number, there was not a more recogniseably edged GS Classes, they were all similar to one another.

	Edge Density	Total Edge (m)
1.	HAG	HAG
2.	F	F
3.	OS	OS

Table 8.3
Paisley, Scotland CA
GS Fragmentation Metrics - Class II
Edge Effect Results

Case Study Area and 10km Extension, Summary FRAGSTATS Analysis

Size Characteristics

Overall, though the size of the area of analysis increased (i.e. CA to 10km), some of the landscape level FRAGSTATS metrics did not change, indicating that landscape fragmentation is consistent when comparing the CA to the 10km for those characteristics only (e.g. SIDI, SHDI, CONTIG). Significant FRAGSTATS analysis results are summarised in Figure 8.55.

The total number of patches, regardless of class, increased from 7532 (CA) to 69,184 (10km). This is consistent with the 10x land increase. The patch density

also remained consistent. This shows that this spatial pattern characteristic in the 10km is similarly fragmented to the CA.

Shape Characteristics

The shape index had similar Means however the Range increased from 97 (CA) to 189 (10km). These results show that the shape of the individual parcels within the 10km are more complex and more irregular shaped, and also larger shaped overall.

Proximity Characteristics

The Nearest Neighbor range increased from 333m (CA) to 1174m (10km), showing that the context of the landscape and its individual patches proximity or distance to another (i.e. center-to-center) increases.

Edge Characteristics

The total number of edges, comparatively, is less within the 10km, indicating that the landscape within the larger region consists of larger parcels with less edges overall, thus less landscape fragmentation.

Size	**Area - Density – Largest**	**CA**	**10km**
	Patch Density (PD)	95 (similar result)	88
Shape	**Regulation - Complexity & Diversity – Typology**		
	Shape Index – Mean	1.4 (similar result)	1.3
	Shape Index – Range	97	189
	Fractal Dimension Index (FRAC)	(similar result)	
	Shannon's Diversity Index (SHDI)	(similar result)	
	Simpson's Diversity Index (SIDI)	(similar result)	
Proximity	**Nearest Neighbour - Isolation & Connectivity**		
	Contiguity Index (CONTIG)	(similar result)	
	Euclidean Nearest Neighbor Index (ENN)	(similar result)	
	ENN - Range	333	1174
Edge	**Total Edge - Longest Edge - Edge Density**		

Total Edge (TE)	2.8mil	16.9mil

Figure 8.55
Paisley, Scotland FRAGSTATS Analysis Results Summary
Case Study Area and 10km Extension

8.3.2 Case Study Area #2: Vantaa and the Helsinki Urban Region, Finland - FRAGSTATS Analysis Results

Case Study Area and 10km Extension, Binary Analysis

Most of the metrics processed provided similar results, those of variability are noted below.

Size Characteristics

The total number of patches, regardless of class, increased from 2193 (CA) to 10,878 (10km). The patch density, however, did not reduce significantly.

Shape Characteristics

The shape index had a mean of 1.2 (CA) vs. 20 (10km) with a range of 1 vs. 29. These metrics show that the shape of the individual parcels within the 10km are more complex, more irregular shaped, and also larger shaped overall.

Proximity Characteristics

The Nearest Neighbor range increased from 35m (CA) to 3840m (10km).

Edge Characteristics

Lastly, the total number of edges increased from 1,158,000 (CA) to 6.128 million (10km). Though the overall land area of analysis increased 10x, the number of edges also grew less than proportionally.

Case Study Area and 10km Extension, Class Level II Analysis

Most of the metrics processed provided similar results and were repetitive to the Land Cover analysis prior as it uses the same Level II Classes. However, notable FRAGSTATS results occurred.

Size Characteristics

The densest patch type in the CA is SHV (n=36) and F (n=27). Within the10km, SHV and F remain highest. For the area metrics, the configuration of the

CA and 10km GS shows AL (n=11) with highest proportion. The GS Class with the largest size range is F (n=553, CA & n=3320, 10km).

Utilising the edge-depth distance of 10m, the Core Index showed that in the CA and 10km, the most widely distributed GS Class was AL (CORE_MN=10.1; CORE_MN=12). Thus, within the larger PUL, the relative GS Class fragmentation remains the same.

Shape Characteristics

Within the shape indices, the most complex shaped (i.e. not regularly shaped) GS is AL (SHAPE_MN=1.6) in the CA and 10kn (SHAPE_MN=1.8).

Proximity Characteristics

Within the Proximity Index, comparatively, the top three (3) GS Classes with the most fragmentation are shown in Table 8.4.

	CA	10km
1.	AL	AL
2.	F	F
3.	PC	PC

Table 8.4
Vantaa, Finland CA
GS Fragmentation Metrics - Class II
Proximity Index Results

The Similarity Index showed that within the CA, there is significant diversity in size and proximity for the all GS Classes excluding PAG and PC – these two were most similarly dispersed within the landscape.

The Euclidean Nearest Neighbor Index (ENN) showed that in the CA, it was the F who were least fragmented – distance wise – to other similar patches (n=58 meters) along with similar distances for PC and SHV. OS, AL, and HAG (n= +/-200m) were the most separated from similar patch Classes. In the 10km, it was again the F and SHV being least separated (n=56m) with most separated being PAG with a significant distance of 1600m compared to the next highest SHV (n=548m).

This characteristic analysis shows that within the larger PUL, PC's are, generally, very far from one another. The most frequently adjacent (PLADJ) and

least interspersed (IJI) and physically connected (COHESION) GS Classes were PC, AL, and PAG in the CA but AL, F, and PC in the 10km showing a prevalence of F in the larger PUL.

Edge Characteristics

Edge wise, the CA showed that the most densely edged GS Classes (See Table 8.5) were F (n=46) and SHV (n=38) and the least were PC (n=.14) and PAG (n=.5). In the 10km, these remained relatively the same, however PAG became the least densely edged (n=.25). The GS Class with the highest total amount (meters) of edges is F within the CA (n=1,210,000m) followed by SHV (n=979,000m). Within he 10km, this order doesn't change (F: n=7,986,000m; SHV: n=5,512,000m). The Edge Contrast Index (ECON) showed that within both the CA and 10km, regardless length or number, there was not a more recogniseably edged GS Class, they were all similar to one another.

	Edge Density	Total Edge (m)
1.	F	F
2.	SHV	SHV

Table 8.5
Vantaa, Finland CA
GS Fragmentation Metrics - Class II
Edge Effect Results

Case Study Area and 10km Extension, FRAGSTATS Analysis Summary

Size Characteristics

Though the size of the area of study increased (i.e. CA to 10km), some of the landscape level FRAGSTATS metrics did not change, indicating that landscape fragmentation is consistent when comparing the CA to the larger region for those characteristics only (i.e SIDI, SHDI, CONTIG). Significant FRAGSTATS metrics are shown below in Figure 8.56.

The total number of patches, regardless of class, increased from 2193 in the CA to 10,878 in the 10km. The patch density is also similar, though slightly less in

the 10km. This shows that the spatial pattern in the 10km is less spatially fragmented and consists of larger parcels than the CA.

Shape Characteristics

The shape index for the CA had a mean of 20 vs. the 10km of 1 with a range of 1 vs. 78 for the 10km. This is quite a significant change. Overall, this result illustrates that the shapes within the CA are more disaggregated, irregularly shaped, and less proximal to similarly shaped patches within the 10km. Said another way, the 10km's landscape parcels are less fragmented than the CA and sit within a landscape of similarly sized and shaped parcels. However, the range of shapes within the 10km are much wider, indicating the variability in shapes is greater within the 10km.

Proximity Characteristics

Per the Contiguity Index results, within the 10km, the patch contiguity lessens, indicating the distribution of similar landscape parcels are more spatially connected within the CA. Said another way, a distribution of larger, more contiguous patches are found within the CA, and these patches are, on average, spatially organised closer and more connected to one another than within the 10km. This characteristic is also reflected in the Contagion Index results.

The Nearest Neighbor range increased from 35m in the CA to 3739m in the 10km, showing that the context of the landscape and its individual patches proximity or distance to another (center-to-center) increased significantly.

Edge Characteristics

The total number of edges increased from 1.2 million in CA to 6.2 million in the 10km. Though the overall land area of analysis increased 10x, the number of edges did not increase proportionally, indicating the landscape parcels within the CA have, overall, more edges than those within the 10km.

Size	**Area - Density – Largest**	**CA**	**10km**
	Patch Density (PD)	16 (similar result)	11

Shape	**Regulation - Complexity & Diversity – Typology**		
	Shape Index – Mean	20	1
	Shape Index – Range	1	78
	Fractal Dimension Index (FRAC)	(similar result)	
	Shannon's Diversity Index (SHDI)	(similar result)	
	Simpson's Diversity Index (SIDI)	(similar result)	
Proximity	**Nearest Neighbour - Isolation & Connectivity**		
	Contiguity Index – Mean	.88	.37
	Contiguity Index – Range	.27	.98
	Contagion Index (CONTAG)	90	33
	Euclidean Nearest Neighbor Index (ENN)	(similar result)	
	ENN - Range	35	3739
Edge	**Total Edge - Longest Edge - Edge Density**		
	Total Edge (TE)	1.2 mil	6.2 mil

Figure 8.56
Vantaa, Finland FRAGSTATS Analysis Summary
Case Study Area and 10km Extension

8.3.3 FRAGSTATS Results Case Study Comparison

Though the FRAGSTATS results are considered absolute, meaning they are specific to each CA and PolyPUR, relative or comparative analysis can be conducted, albeit with an understanding of contextual differences (i.e. spatially, socio-economic, demographic, socio-cultural). Building upon the Land Cover analysis prior, these results provided insight into the current state and relative degree of landscape fragmentation and spatial heterogeneity within the CAs. Most of the metrics processed provided similar results. However, notable comparable results occurred. This comparison looks at Landscape Level Results for the Binary Analylsis (i.e. Green Structure vs Artificial Surfaces) and the Patch Level Results for Class Level II.

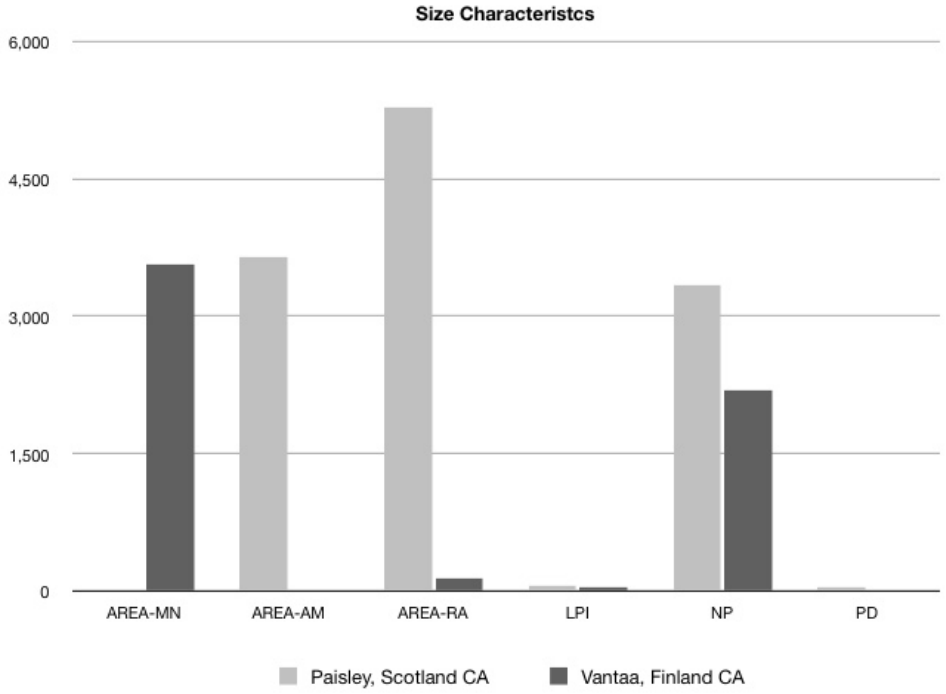
Landscape Level FRAGATATS Results Comparison

Size Characteristics Comparison

As shown in Figure 8.57 and 8.58, the average patch sizes (AREA-MN) within each CA is similar, though Paisley CA is slightly smaller. Also, the Range of sizes is notably larger withint he Paisley CA. The FRAGSTATS results show that there is a significant higher PD within the Paisley PUL. However, the PD in the Vantaa PUL does not differ much between its CA and 10km, indicating a similarity and consistency in urbanisation and landscape fragmentation impacts. PD for the Paisley CA decreased when analysed in the 10km, whereas not so much in the Vantaa 10km. This indicates that the spatial distribution of patches within Paisley's CA becomes less spatially fragmented whereas in the Vantaa CA it remains relatively the same.

BINARY LANDSCAPE METRICS	Area Index - Range Size	Largest Patch Index	Patch Number	Patch Density
	AREA-RA	LPI	NP	PD
Paisley, Scotland CA	5,291	67	3,352	42
Vantaa, Finland CA	144	50	2,193	16
	AREA-RA	LPI	NP	PD
Paisley, Scotland 10km	26,146	33	18,432	23
Vantaa, Finland 10km	25,560	26	10,878	11

Figure 8.57
FRAGSTATS Case Study Analysis
Size Characteristics Comparison



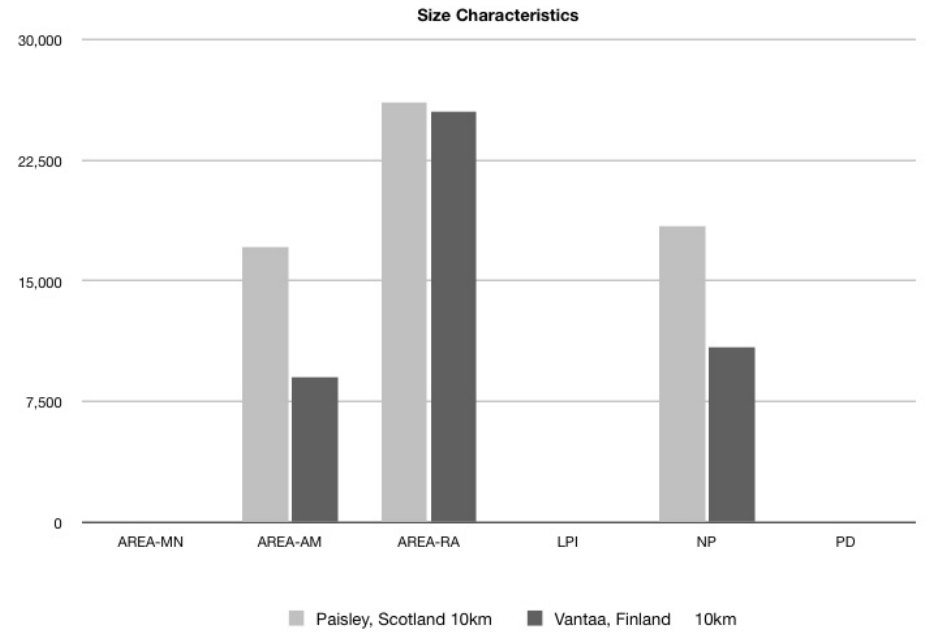


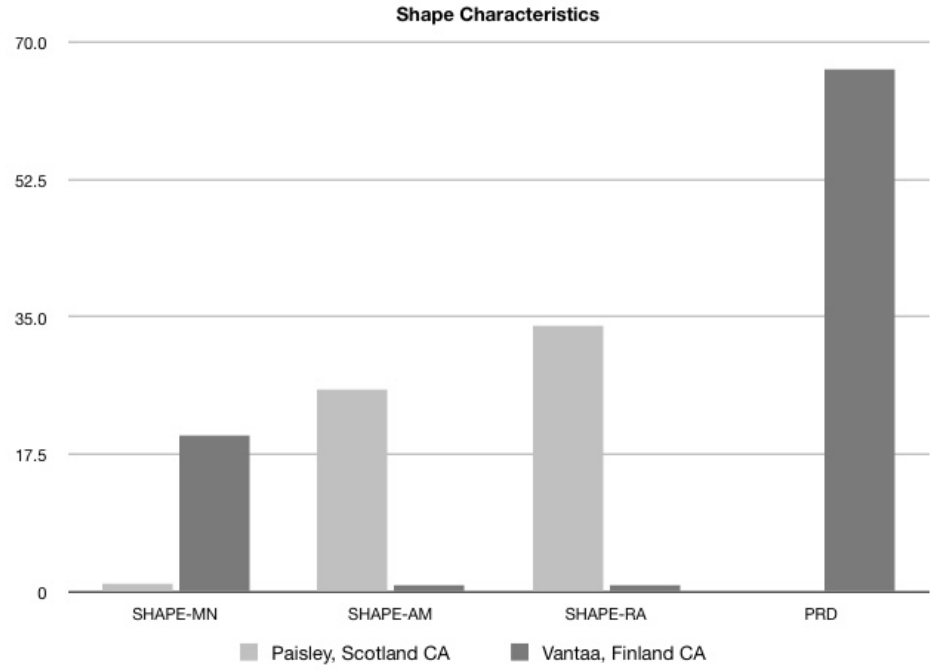
Figure 8.58
FRAGSTATS Case Study Analysis
Size Characteristics Comparison
Case Study Area and 10km Extension

Shape Characteristics Comparison

As shown in Figure 8.59 and 8.60, the overall landscape shape metrics in the Vantaa PUL change more noticeably than the Paisley PUL in regards to the CA and 10km. Specifically, these results illustrate the configuration of the shapes of the parcels and richness density within the Vantaa PUL 10km are more complex and diverse, or fragmented, indicating denser urbanisation and human development than the Paisley CA 10km. Vantaa's CA overall higher mean shape metrics within the index indicates lesser edge effect (i.e. more edge & less breadth) than Paisley's CA. Thus, Paisley's CA parcels have what is considered a less effective ecological size – less ecological integrity - for certain species such as forests, avian species, and some larger mammals. For example, within a dense forest, the larger the shape index metrics, the more of the patch is affected by light, wind and the species that inhabit neighbouring patches. Thus a higher shape index is indicative of poorer ecological quality. Anthropologically, a higher shape index would result in more noise and light penetration as well as visibility both within and out from the GS patches.

BINARY LANDSCAPE METRICS	Shape Index - Mean Size	Shape Index -Weighted Mean Size	Shape Index - Range Size	Patch Richness Density
	SHAPE-MN	SHAPE-AM	SHAPE-RA	PRD
Paisley, Scotland CA	1.2	25.8	34	0.0252
Vantaa, Finland CA	20	1.0	0.9	66.6
	SHAPE-MN	SHAPE-AM	SHAPE-RA	PRD
Paisley, Scotland 10km	1.3	51.9	109	0.0025
Vantaa, Finland 10km	1.3	28.6	78	0.0021

Figure 8.59
FRAGSTATS Case Study Analysis
Shape Characteristics Comparison



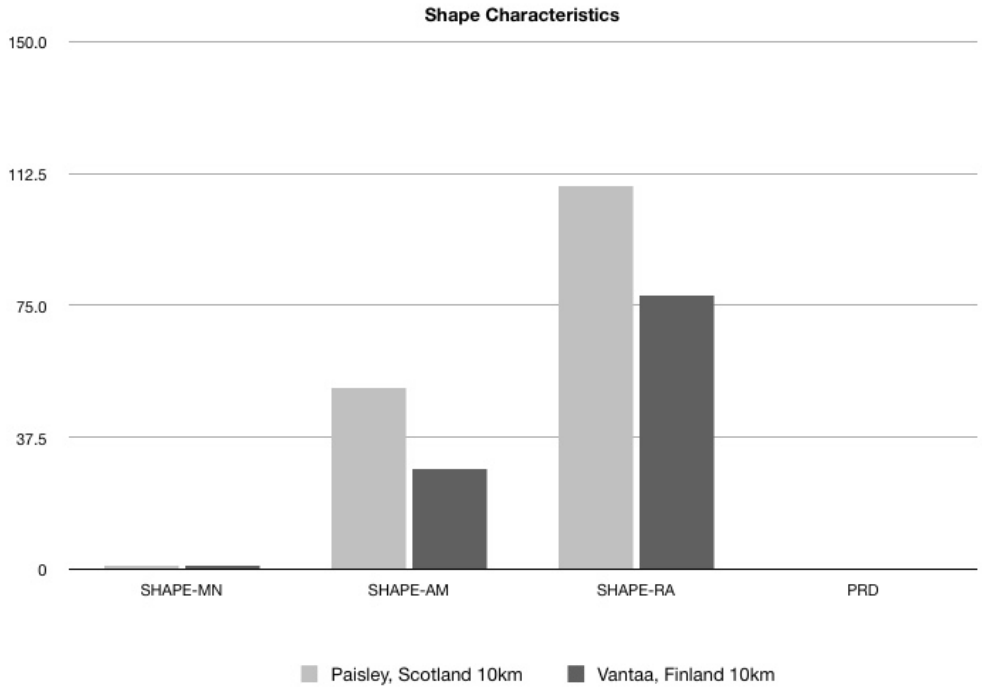


Figure 8.60
FRAGSTATS Case Study Analysis
<u>Shape Characteristics Comparison</u>
Case Study Area and 10km Extension

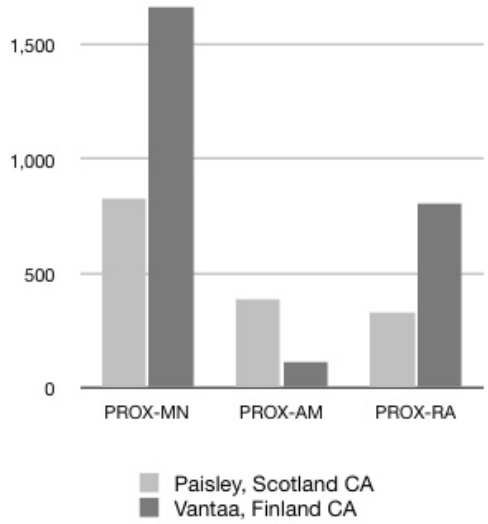
Proximity Characteristics Comparison

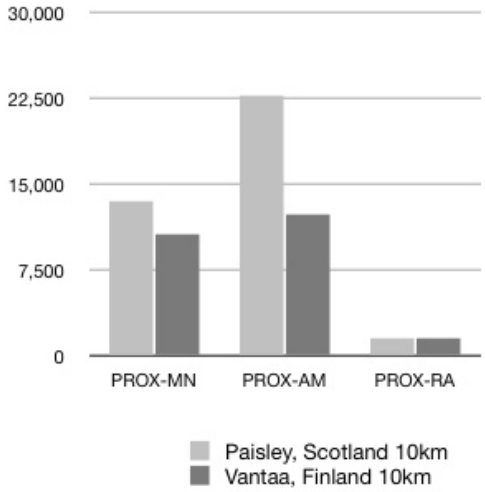
As shown in Figure 8.61 and 8.62, the Vantaa CA's spatial distribution of parcels is less varied, less distributed, more physically connected, and less isolated than the Paisley CA, indicating that urbanisation and landscape fragmentation is, overall, less - comparatively, but only between their CA's.

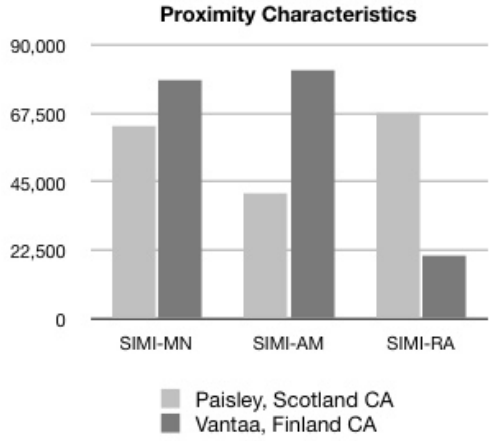
This characteristic is also reflected in two diversity indices, Shannon's Diversity Index (SHDI) and Simpson's Diversity Index (SIDI). Both illustrate spatial heterogeneity in its measurement (Díaz -Varela et al. 2009), combining richness and evenness measures into a single metric of proportional abundance and is common within community ecology studies (McGarigal and Marks, 1995). SHDI increases as the number of different patch types increases and the proportional distribution of area among patch types become more equitable. SIDI increases as the proportional distribution decreases. Comparatively, the Paisley region's SHDI is 1.5 and 1.9 for its CA and 10km, whereas the Vantaa regions score is 0.5 and 0.7. This finding, as well as the SIDI results, supports other findings that the Vantaa PUL is, comparatively, less fragmented and less impacted by urbanisation pressures than Pthe aisley PUL.

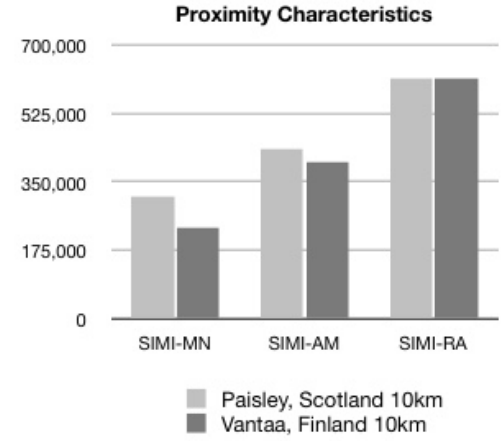
BINARY LANDSCAPE METRICS	Similarity Index - Mean	Similarity Index - Weighted Mean	Similarity Index - Range	Proximity Index - Mean	Proximity Index - Weighted Mean	Proximity Index - Range	Contiguity Index - Mean	Contiguity Index - Weighted Mean	Contiguity Index - Range	Nearest Neighbour - Mean	Nearest Neighbour - Weighted Mean	Nearest Neighbour - Range
	SIMI-MN	SIMI-AM	SIMI-RA	PROX-MN	PROX-AM	PROX-RA	CONTIG-MN	CONTIG-AM	CONTIG-RA	ENN-MN	ENN-AM	ENN-RA
Paisley, Scotland CA	63,630	41,569	67,707	833	393	33,144	0.17	0.85	0.93	52	41	333
Vantaa, Finland CA	78,539	81,753	20,983	1,668	117	8,122	0.89	0.17	0.27	41	44	35
	SIMI-MN	SIMI-AM	SIMI-RA	PROX-MN	PROX-AM	PROX-RA	CONT-MN	CONT-AM	CONT-RA	ENN-MN	ENN-AM	ENN-RA
Paisley, Scotland 10km	312,703	437,723	615,966	13,572	22,782	163,574	0.20	0.88	0.96	50	41	1,174
Vantaa, Finland 10km	236,003	401,790	614,144	10,670	12,332	159,807	0.37	0.90	0.98	65	42	3,357

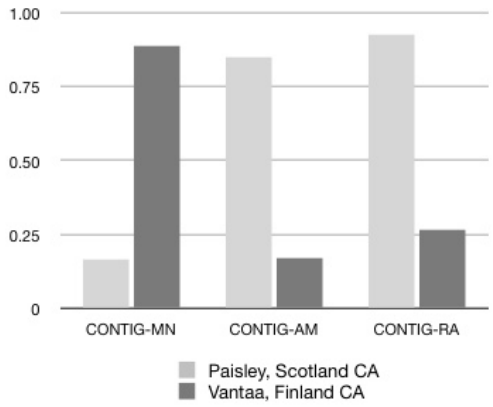
Figure 8.61
FRAGSTATS Case Study Analysis
Proximity Characteristics Comparison

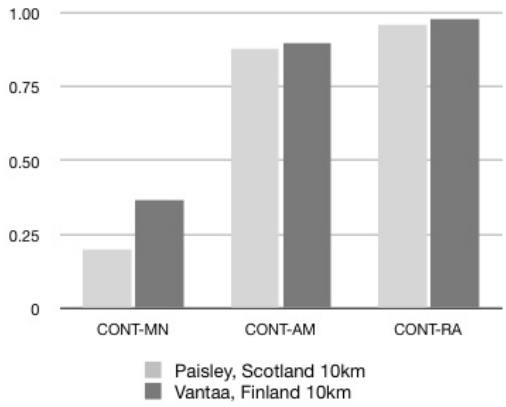

1,500
1,000
500
0
PROX-MN
PROX-AM
PROX-RA
Paisley, Scotland CA
Vantaa, Finland CA


30,000
22,500
15,000
7,500
0
PROX-MN
PROX-AM
PROX-RA
Paisley, Scotland 10km
Vantaa, Finland 10km


Proximity Characteristics
90,000
67,500
45,000
22,500
0
SIMI-MN
SIMI-AM
SIMI-RA
Paisley, Scotland CA
Vantaa, Finland CA


Proximity Characteristics
700,000
525,000
350,000
175,000
0
SIMI-MN
SIMI-AM
SIMI-RA
Paisley, Scotland 10km
Vantaa, Finland 10km


1.00
0.75
0.50
0.25
0
CONTIG-MN
CONTIG-AM
CONTIG-RA
Paisley, Scotland CA
Vantaa, Finland CA


1.00
0.75
0.50
0.25
0
CONT-MN
CONT-AM
CONT-RA
Paisley, Scotland 10km
Vantaa, Finland 10km

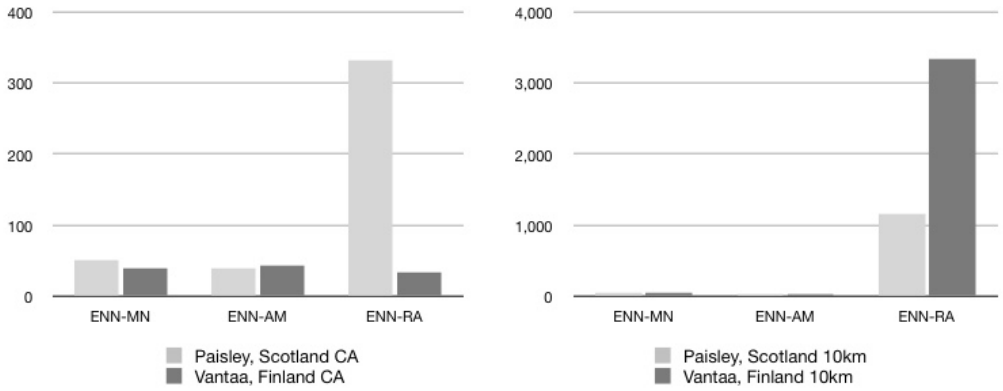


Figure 8.62
FRAGSTATS Case Study Analysis
Proximity Characteristics Comparison
Case Study Area and 10km Extension

Edge Characteristics Comparison

As shown in Figure 8.63 and 8.64, comparatively, the Vantaa region contains less edges, overall, than the Paisley region. This also indicates less edge disturbance, less landscape fragmentation and less impacts of urbanistion due to human development pressures.

BINARY LANDSCAPE METRICS	Edge Contrast Index - Mean	Edge Contrast-Weighted Mean	Total Edge	Edge Density	Contrast Weighted Edge Density
	ECON-MN	ECON-AM	TE	ED	CWED
Paisley, Scotland CA	48	44	986,000	124	62
Vantaa, Finland CA	45	44	1.1 Million	88	43
	ECON-MN	ECON-AM	TE	ED	CWED
Paisley, Scotland 10km	49	43	8 Million	100	50
Vantaa, Finland 10km	47	42	6.1 Million	62	32

Figure 8.63
FRAGSTATS Case Study Analysis
Edge Characteristics Comparison

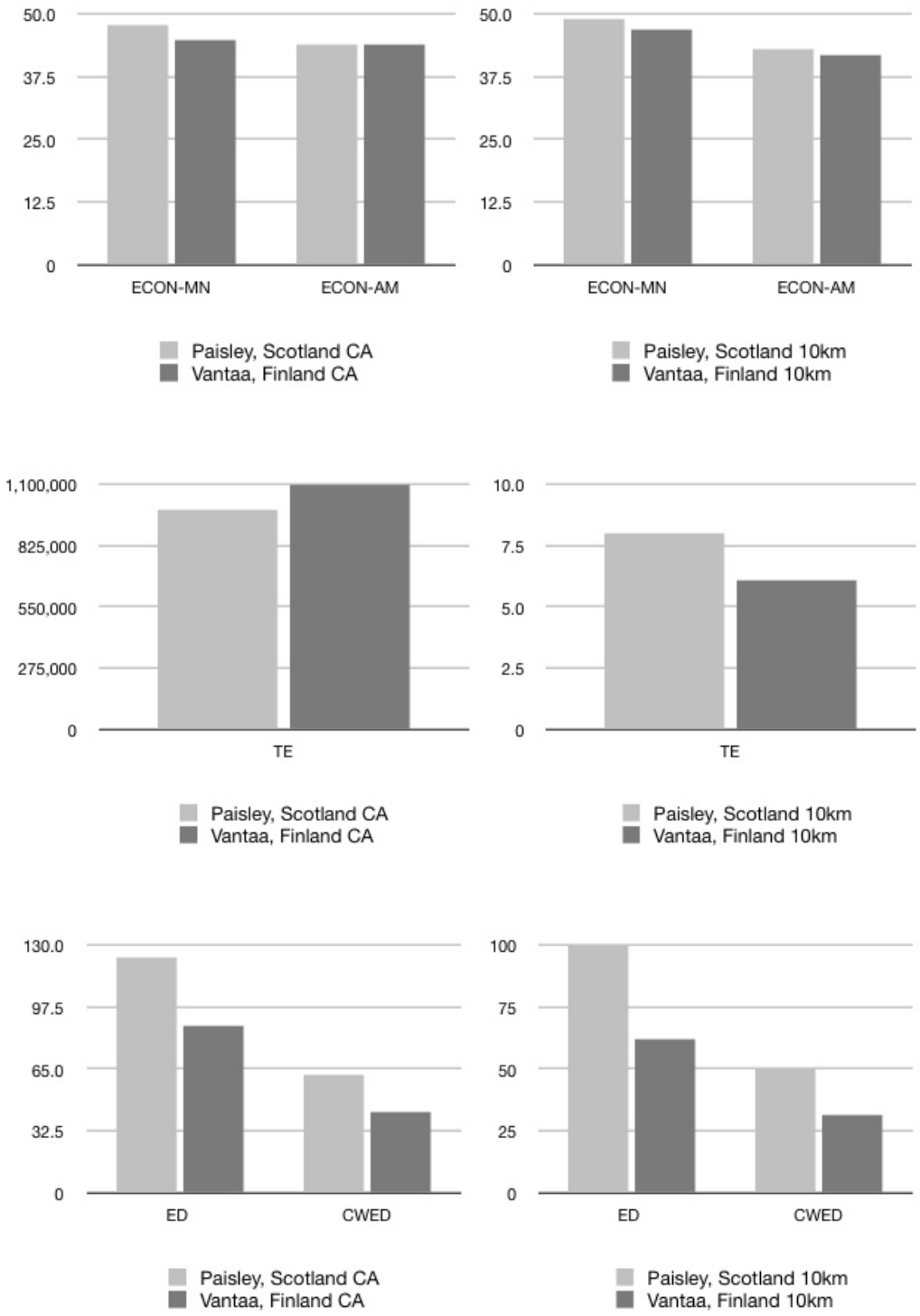


Figure 8.64
FRAGSTATS Case Study Analysis
<u>Edge Characteristics Comparison</u>
Case Study Area and 10km Extension

Class Level II FRAGATATS Results Comparison specific to GS

The various types or Classes specific to GS and their characteristics of fragmentation differ between case study regions, regardless of overall area.

The results show that Vantaa's spatially dominant GS, F are also the most distributed. Paisley's spatially dominant GS, OS is also the most widely distributed. This measure shows that there are many, smaller OS within each CA. Though both regions had F as the second most fragmented landscape classification typology, the Paisley region reported it's OS as the most fragmented and the Vantaa region reported AL (See Figure 8.64). This is a difficult interpretation as these two typological classifications are quite similar and, in fact, may be referring to similar GS characteristics (e.g. open land, little vegetation, undeveloped land). However, these GS typologies are the most frequently developed landscape types found within the urbanisation process within PURs and is important to note.

GS Fragmentation Ranking (per Proximity Index)	Paisley Case Study Area	Vantaa Case Study Area
1	Open Space	Arable Land
2	Forest	Forest
3	Arable Land	Permanent Crops

GS Fragmentation Ranking (per Proximity Index)	Paisley Case Study Area 10k	Vantaa Case Study Area 10k
1	Open Space	Arable Land
2	Shrub and/or Herbaceous Vegetation	Forest
3	Forest	Permanent Crops

Table 8.6
GS Fragmentation Metrics - Class II
Case Study Area and 10km Extension Comparison

The three most spatially fragmented GS in Paisley are OS, F, AL compared to AL, F, PC for Vantaa. This signifies that both areas have fragmented forests and agricultural lands. However the qualities of this fragmentation differ between CAs. The F in Vantaa is overall more fragmented than Paisley however the Paisley F patches are located closer to one another. Similarly, in Vantaa it was the AL and SHV patches, overall, most separated, distance wise, from one another whereas HAG was the physically nearest class of fragmented patches. In Paisley, the OS patches were the most distant class of fragmented patches.

Both study areas have fragmented forests with many dense edges, however Paisley exhibits dense edges for HAG whereas Vantaa does so for SHV. The least dense edges were PAG and AL for Paisley and PAG and PC for Vantaa, typical for open field typologies. In Paisley's CA, The GS Class with the highest total amount of edges (in metres) is F within the CA, followed by SHV. In Vantaa, it was HAG and F, illustrating, as before, that the most widely distributed GS Class, forests, also have the most edges.

Within Paisley 10km, SHV are the highest mean sized GS whereas it is AL in Vantaa. The most complex shaped GS overall, however, are AL for Vantaa and SHV and F for Paisley, whereas the most spatially fragmented and most dense GS are HAG and F for Paisley and SHV and F for Vantaa.

Most of Vantaa's forested GS are larger in size with simpler shapes. And the larger the forest size, the increased likelihood that it is connected or proximal to another larger forest GS. Paisley's OS, generally, do not include as many smaller, complex, finely textured GS as Vantaa; being mostly medium-sized and, interestingly, evenly distributed throughout the urban fabric.

Although the Paisley CA is more fragmented spatially, overall, there is not a significant increase in its number of GS edges, indicating that though there are less patches to Vantaa's GS, they are more complex in shape.

The shape complexity of GS in the Vantaa CA is significantly less than that of Paisley in both CA and 10km, and those GS within the Paisley CA are more irregularly shaped, as well as larger overall, when compared to that of Vantaa. Spatial fragmentation as measured by the various GS class metrics show that the overall distance between GS patches is more than three times higher for the study areas of Vantaa than for Paisley in both the CA and 10km, signifying that the Vantaa CA's GS are less fragmented in this regard.

Appendix 4 provides a succinct discussion on the limitations found within the FRAGSTATS analysis, results and comparisons. It is important to note that these results represent an abstract representation of the spatial GS and landscape fragmentation and its content and composition within the CAs and PolyPURs.

Redundancy and overlapping metrics is common, often confounding accurate interpretation.

8.3.4 Landscape Fragmentation and Green Structure Characteristics Geospatial Analysis Summary

The geospatial analysis provides spatial and nonspatial information about the quantity and qualities of fragmentation characteristics of the landscape and their GS within the case studies. For example, how is this GS distributed? Is the GS comprised of large reserves or is it a series of smaller, integrated GS? It is these characteristics that make them distinct from the rural or urban zones.

The case studies as well as their GS exhibited distinct spatial heterogeneity, GS diversity, and edge effects. The Class Level I and Class Level II Land Cover and the FRAGSTATS results provided important quantitative information on both the levels of spatial heterogeneity and measures of fragmentation for the GS of each study area. Together, both analyses provided an empirical fragmentation analysis but did not focus on habitat or other ecological features, but rather the overall landscape composition and pattern. This goespatial analysis viewed spatial-based fragmentation for multiple Land Cover Classes and their features to best comprehend the level of fragmentation in the natural and built landscapes of the regions of study (e.g. CA and 10km).

Paisley's spatially dominant GS, OS is also the most widely distributed; however, Vantaa's spatially dominant GS, F, is not the most widely distributed: that is AL. Both case study catchment areas exhibit spatial fragmentation, but in slightly different means and characteristics. Whereas both CA's have a strongly adjacent and connected set of GS – AL and PAG, Paisley shows a stronger connectivity for OS whereas Vantaa exhibits this for PC. In Paisley, OS are the highest mean sized GS, or most distributed within the CA, as well as having the largest size range. In Vantaa, however, AL are the highest mean sized GS, or most distributed within the CA, but forests have the largest size range and are also the most complex shaped.

Overall, spatially, all GS within the Vantaa CA are similar in size and proximity to one another, indicating a level of homogeneity in their distribution and other physical characteristics, whereas Paisley's CA shows a strong diversity in

size and degree of proximity to one another, except the PAG and PC GS types. Thus, there are distinct GS typologies that exhibit fragmentation more than others within the Paisley CA – HAG and F notably.

As shown in Table 8.7, although Paisley has a smaller physical area to its CA than Vantaa, it has more total patches, indicating a distinct fragmented spatial arrangement. Paisley also has more complex shapes, which is interesting because Vantaa has more total edges. This can be accounted for by Vantaa's larger total area, however. Vantaa's higher proximity and less separated GS metrics illustrate a more distinct green structure – those interconnected, contiguous GS – within the CA.

Metrics Comparison	# Patches	Complex Shapes	Separation	Edges
Paisley CA	More	More	Lesser	Less
Vantaa CA	Less	Less	Greater	More

Table 8.7
FRAGSTATS Result Comparison

Quantitatively, compared to the GS within the 10kms, the CA's IntGS, overall, are smaller in mean size, there are more of them, and they contain more edges with more diverse shapes. These GS are less connected and less proximal to one another, with a lower per-capita/hectare relationship (Figure 8.15 and Figure 8.16). As discussed, however, there are differences in the overall GS of the two CAs.

The geospatial analysis of the Paisley, Scotland and Vantaa, Finland 10km has provided a biophysical and spatial context in which to examine the human-nature relationship further. For example, the Vantaa CA has nearly 35 million more square metres of GS than the similarly sized Paisley CA, but this does not describe the specific characteristics of these GS. Both CA's have an overall landscape texture of smaller, finely shaped patches. Overall, although Vantaa has larger sized GS patches, it also has a larger number of smaller, compact complex shaped GS – particularly its OS and P, indicating a diffused pattern to its overall GS. In the Paisley CA, there are significantly less F, and its OS are more contiguous and larger in size than its other GS types. These larger GS, however, generally have

little interconnectivity to one another, providing for a less dense distribution than Vantaa's GS. Both CA's GS are concentrated along their linear water corridors, although much less so within Paisley's urban centre. This element highlights how Vantaa's GS are more proximate to and interconnected with adjacent GS, even though the overall linear length of those water corridors is similar within each CA.

This research's comprehensive geophysical analysis of GS was limited by the quality of the data available, specifically how green space and green structure is defined between the case study areas. A common definition of green space between the two regions is currently lacking – green structure data was often incomplete and municipal boundaries often caused misrepresentations, making direct comparisons was challenging and, thus, validity should be questioned; the type and amount of GS are similar as illustrated, but this information may not be completely accurate. The absolute and relative measurement results and ratios listed provide important information, but insights can be improved when correlated to specific spatial measurement such as Land Cover and FRAGSTATS.

8.4 Case Study Spatial Landscape Analysis Results: Green Space and Green Structure Comparison

This spatial analysis determined two significant physical characteristics common between both CAs: 1. morphologically polycentric urban regions, and 2. PolyPURs which include fragmented landscapes and spatially heterogeneous IntGS.

This section provides a cursory overview of and comparison between the current states of the spatial landscape and GS within the selected CAs. The landscapes are currently in a fragmented state and face further pressure for continued spatial fragmentation, particularly in respect to their PPUIGS.

Within the CA's and larger 10km extensions, a variety of green structures and green spaces exist. They vary from large, naturalistic and open to small, urban and dense. A listing of all GS with their associated characteristics is not feasible; however further analysis of their GS supports this research's objectives.

8.4.1 Case Study Area #1 - Paisley and the Greater Glasgow Urban Region, Scotland

The spatial landscape analysis illustrated that although there is a high amount of GS overall within the CA (24,278,300 sqm), these GS are located in two specific locations (See Figure 8.54), physically connected to the larger PUL and to one another, and thus exhibiting connected GS characteristics. Together, these two agglomerations (approximately 13,210,000 sqm) are a significant portion of the overall CAs landscape (41%) and GS (54%).

The largest GS is Pollock County Park (146 hectare), the smallest being various garden plots attached to homes. Many medium to large sized GS include golf courses and sports fields. GS at various scales surround many of the water-based typologies such as, the River Clyde and White Cart Water. Compositionally, a series of small to medium sized (.5 ha – 10 ha) GS are dispersed throughout the catchment area; two significant areas of large, connected GS exist around Pollock Country Park and Ralston Golf Course. These two large GS are physically connected by the GS around the White Cart Water that travels through both spaces.

Within the 10km there are many large GS including Gleniffer Braes Country Park, Seven Lochs Wetland Park, and Dams to Darnley Country Park. Only some portions of the much larger Clyde Murishiel Regional Park are within the 10km. Compositionally, though the landscape is predominately compromised of GS, these are of different land uses such as agricultural, forestry and grasslands (i.e. diversity), which account for many smaller, individual GS (i.e. patches). Overall, however, the 10km has a distinct GS composition of connectivity (See Figure 8.53), though this is more significant externally than internally. The structural composition of this area illustrates a continuous GS surrounding the polycentric sub-centres and the Glasgow urban centre, adjacent to and further beyond the PUAs, referred to as a greenbelt. The CA's GS intervene at certain points into both the larger PUA, creating physical connections to this larger, unfragmented greenbelt structure. However, the CA's GS do not physically connect to Glasgow's City Centre to the greenbelt.

Although the 10km and GGUR contains spatially interconnected GS, these are actively facing fragmentation pressures to meet continued human development

requirements. Notably, the urbanisation process in the GGUR has not always been upon greenfields or GS; for example, the ongoing (2016) Clyde Waterfront regeneration project (www.clydewaterfront.com) accounts for over 200 urban renewal projects, most upon disused brownfield sites along a 20km stretch of the Clyde River near central Glasgow.

8.4.2 Case Study Area #2 - Helsinki and the Helsinki Urban Region, Finland

The spatial landscape analysis illustrates that though there is a high amount of GS overall (39,041 000 sqm) within the CA, these GS are located in two specific locations (See Figure 8.65). These two GS agglomerations, i.e. 'Green Fingers' are physically connected to the larger PUL and the city centre, exhibiting connected GS characteristics (See Figure 8.66). Together, these GS are a significant portion of the overall landscape (31%) and GS (66%) of the CA.

Within the CA, the largest individual GS is Paloheinä, sometimes referred to as Paloheinä Forest or Paloheinä Recreation Area, and is part of the Helsinki Park 'Green Finger', thus its size determination is not possible. Many medium to large sized GS include woodlands, golf courses, and sports fields. GS at various scales surround many of the water-based typologies such as, the Vantaa River and the Keravanjoki, a tributary of the Vantaa River that flows into the Gulf of Finland within the CA.

Historically, during Swedish reign (1550-1809) Helsinki was a small provincial coastal town located on a narrow peninsula jutting out to the sea. The town had small wooden houses and partially open landscapes (e.g. rural pastures and fields, surrounded by the Baltic Sea and rural landscapes). The first public urban park (Kaisaniemi Park) was established in 1829. The Esplanade Park was created in 1881 and became the most fashionable promenade of the elite classes in the city centre.

The Greater Helsinki (*Pro Helsingfors*) Master Plan of 1918 had significant UGS. Leto notes that Finland's independence provided an opportunity to redefine and progress the Country's national identity (The Role of Nature in the City, Katri Lento, p 189). Helsinki, the Country's capitol, served as this idea's symbol and exemplification. The 1918 Master Plan mimicked the English Garden City concept

and included a defined urban core or a city centre with wide boulevards extending towards a series of suburban towns in the outer areas, each of town separated by large parks and farmlands. This Master Plan elicited the 'new' Finland's desired qualities of order and efficacy together with a closeness to nature and leisure opportunities for its citizens.

As Helsinki's new identity continued to emerge in the 1920's, Modernism and urban nature romanticism was influencing the spatial planning of the region. Functionalism, a uniquely Nordic modernist approach, had impact in Finland's post-war era. Evolving from Garden City principles, this Functionalist urban planning, led by Alvar Aalto, placed nature 'practically' within current public and social concerns. As post-war populations increased, Finland set about to create large scale residential projects within the suburbs of Helsinki. They were called Garden Suburbs, or here, given the Nordic context, Forest Suburbs, as it was the forests which was the only land available in these PURs such as within Tapiola.

Helsinki's urban expansion in the late 19th and early 20th Century occurred along the two railway lines to the north-west and north-east of the city centre, leaving the in-between areas and the complex-edged water bays mostly unbuilt. It was this infrastructure that created the basis for the 'Green Finger' structure of Helsinki.

The Master Plan of 2002 provided names to the 'Green Finger' structure of Helsinki and it's larger Urban Region. They are referred to by the names West Park, Central Park, City Cultural Park, Helsinki Park, the Viikki-Kivikko Park, East Cultural Park and Vuosaari Park (Helsinki City Planning Department, Environmental Office, 2002). Overall, these are structured as an interconnected, continues system of GS in a linear format, a 'greenway'. Greenways are *"established along either a natural corridor, such as a riverfront, stream valley or a ridgeline ---- or a right-of- way converted to recreational use"* (Little 1990, quoted by Ahern 2003) or a network of land that is "*planned, designed and managed for multiple purposes including ecological, recreational, cultural, aesthetic or other purposes compatible with the concept of sustainable land use*".

The Greater Helsinki Region's 'Green Fingers' form the backbone of the

HUR's green space system. These structures extend from the seashore to the city limit and beyond into the peri-urban areas in a radial manner. Interconnected by a network of square parks, boulevards, pedestrian walkways, seaside promenades, narrow strips of nature, green belts and green corridors, they serve a variety of socio-ecological services with the larger structures serving as ecological corridors. These 'Green Fingers' often follow a natural feature, such as a river corridor, and the sea areas of archipelagos are also considered another entity connecting the 'Green Fingers' to one another. The HUR's shoreline is long and there are hundreds of islands, most of which are small rocky outcrops from the sea.

The 'Green Finger' structure has components of various separate 'fingers' (See Figure 8.52). The Helsinki Park finger is almost completely inclusive within the CA as this encompasses the Vantaa River starting from Vanhakaupunki Bay near Lammasaari. Helsinki Park borders the Central Park finger at Paloheinä and the CA includes small portions of this. Lastly, the CA includes almost all of the Viikki-Kivikko Park finger.

Within the 10km, all of the 'Green Finger' parks are included, and there are many large GS as well. Notably, this area includes the Sipoonkorpi National Park; though not significant in size, it is one of only 39 National Parks within Finland and is a multi-use, cultural and landscape park. The largest park is Helsiki's Central Park (Keskuspuisto) and is over 10km in length and over 1000ha in size and is considered the central 'finger' of the Helsinki 'Green Finger' green space structure. This greenway park includes the City Cultural Park 'finger' and extends all the way from the banks of Tooloo Bay in the south through the city centre to old-growth forest (Hietala, et al., 2013) bordering Paloheinä Forest in the north. This park dates from the early designs of the city core, such as Bertel Jung's and Eliel Saarinen's green plans in the beginning of the 20th century.

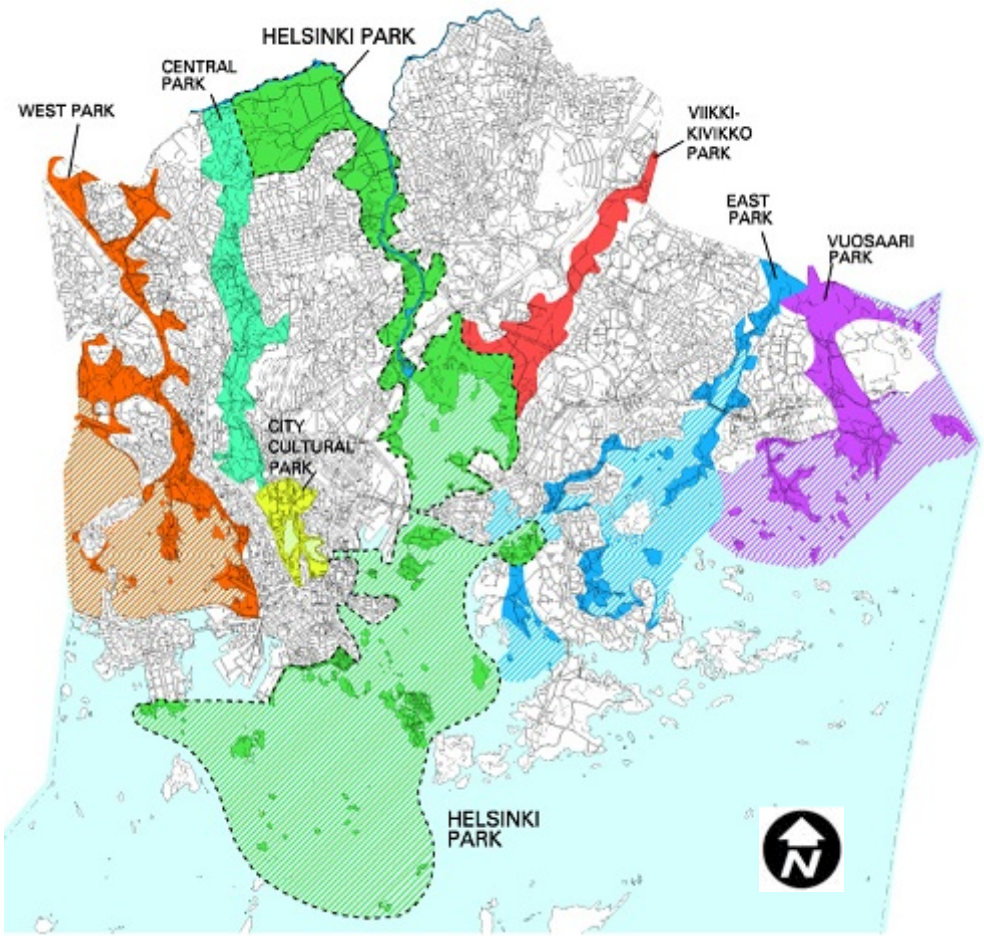


Figure 8.65
Helsinki Green Finger Diagram
(Source: Green areas system in Helsinki, Helsinki City Planning Department, Environmental Office, 2002)

The GS in the CA are mainly young forests, former agricultural lands and narrow forested belts. The majority of all green areas within the HUR (65%) are urban woodlands located within housing areas. Older woodlands, those over 100-years old, are rare in the study area, only 3% in all. The majority of the woodland is less than 60-years old and the woodland landscape is dominated by Scots pine (*Pinus silvestris*) and silver birch (*Betula pendula*) (Helsinki Green Area Division, 2002). Forests are a significant natural feature in Finland and the HUR and provide economic, environmental, social, and cultural benefits.

Overall, the 10km has a distinct GS composition of connectivity, (See Figure 8.49). The structural composition of this area illustrates a distinct, continuous GS surrounding the outer edges of the PUAs. When you consider the water spaces, the

typical ‘green belt’ structure ensues.

In the City of Vantaa, fifty percent of the area is designated for green areas, which form a continuous GS network with less than 300 meters to the closest green space (State of the Enviroment, 2012). Vantaa’s GS network is based on 1960s-70s urban planning, which acknowledges the importance of a good GS network to residents’ welfare. As such, older housing areas include many small houses and did not originally have any parks; these unbuilt sites were later turned into public GS. The more current forest-suburbs ‘have good internal green-area networks’ (ibid).

The ‘Green Fingers’ are greenways serving as integrated functional socio-ecological networks linking urban and rural areas (Ahern, 2003). The ‘Green Fingers’ is a simple concept used for defining the core structure of ‘green’ in the HUR. Surprisingly, it does not contain any specific policy instruments to maintain and strengthen the status of this basic structure as it essentially is a group of various municipally managed GS within a larger, conceptual spatial form. Although ‘Green Fingers’ is a strong mental structure within the cultural mindset of many residents (ibid), no practical legislation currently exists to maintain the integrity of these GS. As urbanisation has increased, the need for transportation infrastructure has led to ring-roads which bisect the fingers.

Adding to the policy-driven concerns of the ‘Green Fingers’ within the HUR is the socio-political context surrounding GS. Spatial planning has not required GS to be a key concept in Finland. Most planning refers to these GS through their actual uses such as agriculture and forestry. In the 1970’s, GS was hardly mentioned; it was ‘recreational area’ which was the key term that consisted of forests, parks meadows and fields. The 1983 Master Plan for Vantaa placed GS as only a conventional park and nothing else (Vantaa, 1983). The current Master Plans for both Helsinki and Vantaa still provide ‘green space’ as a general concept referred to throughout and supply more precise terms such as forest, nature reserve, recreation, etc. as needed. But the typological limitation and unclear definitions of GS still exist.

Furthermore, the City of Helsinki owns most of the GS marked on its master plans, whereas in Vantaa the marked GS are primarily privately owned. (Jaakkola,

2012). And while both cities have established nature reserves, it was only recently that these GS have become legally protected from development and recreation through the Natura 2000 policy.

Currently (2016) GS cover extensive areas of both Helsinki and Vantaa, although developed areas within both cities have increased since the late 1960s. Helsinki and Vantaa, however, have opted for different policies concerning urbanisation. Helsinki has focused on densification whereas Vantaa, being more rural in character, only moved to densification policies in the 1990's after decades of detached housing patterns (Hannikainen, 2013). The Helsinki-Malmi Airport is located within the CA and is still actively used in general aviation and flight training, even though commercial air travel moved to Helsinki Airport in 1952. Although the airport currently functions as a large GS, the City of Helsinki has not completed its plans to convert the airport for new residential areas due to ongoing public debate.

The 10km and larger HUR contains spatially interconnected GS beyond the urbanised conurbations, yet these GS are actively facing fragmentation pressures to meet continued human development requirements.

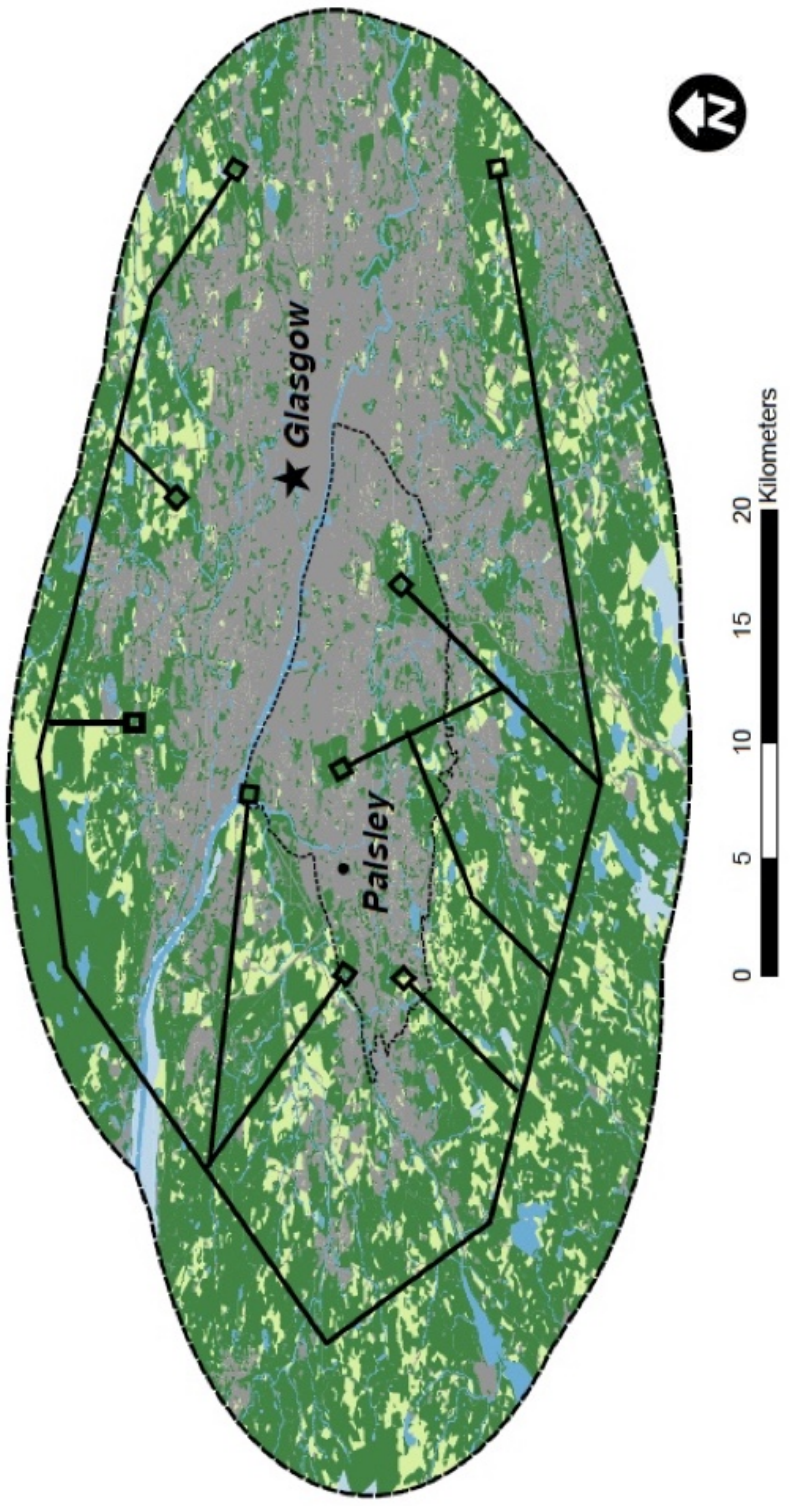


Figure 8.66
Paisley, Scotland Case Study Area – 10km Extension
Green Structure Connections to Regional Greenbelt Structure in Black

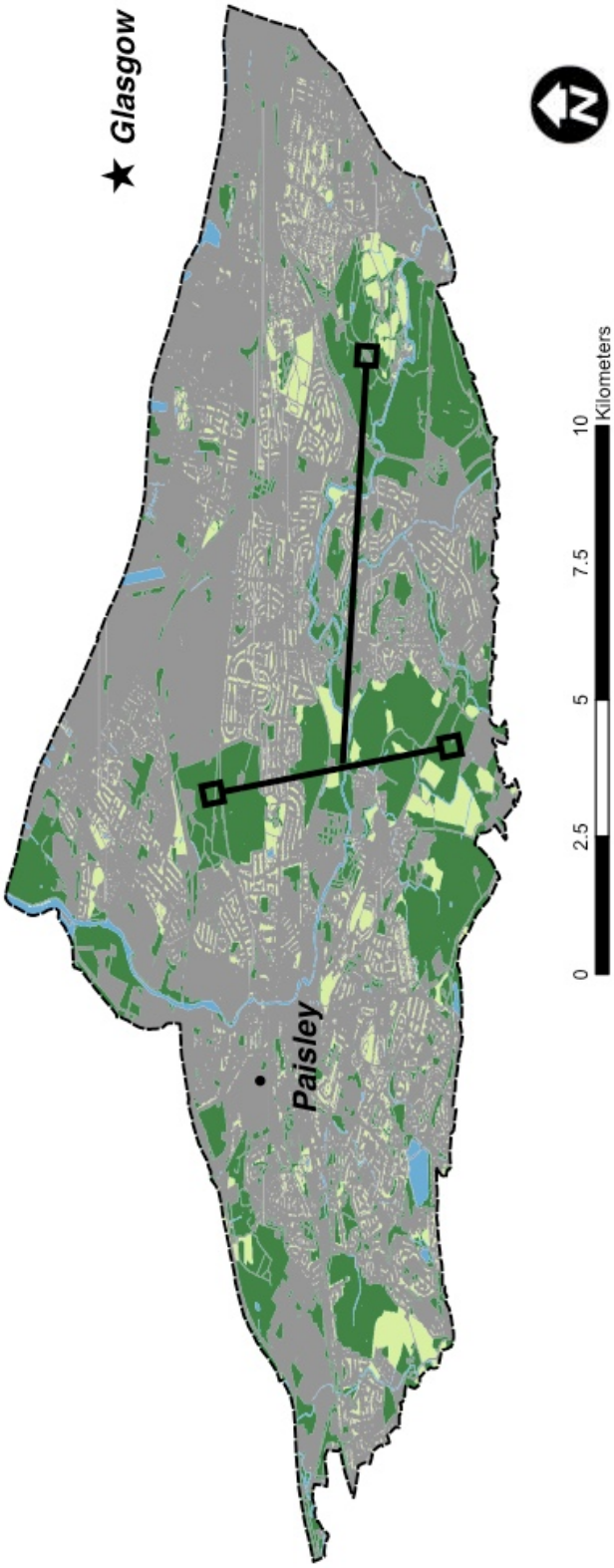


Figure 8.67
Paisley, Scotland Case Study Area
Green Structure Connections in Black

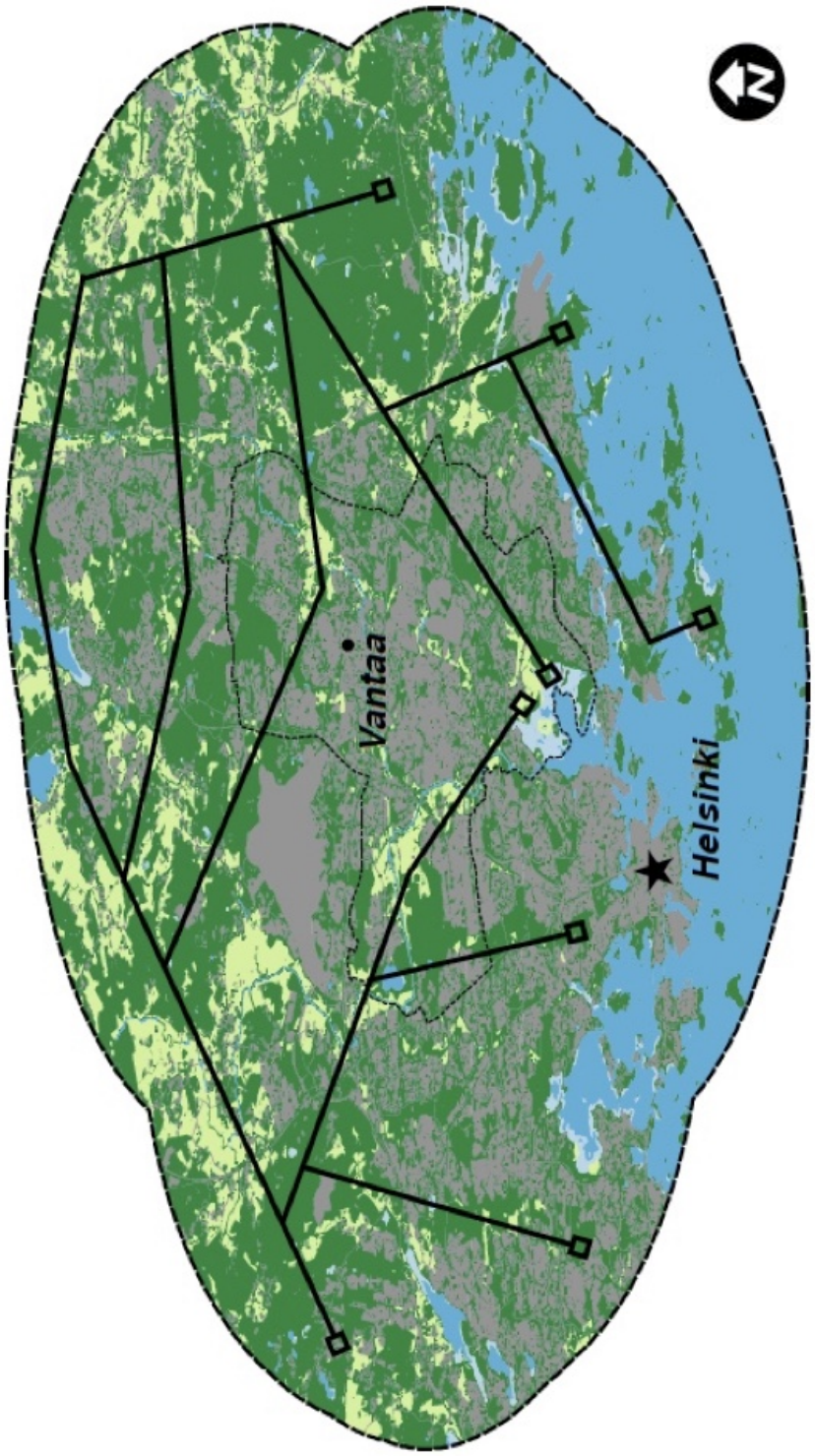


Figure 8.68
Vantaa, Finland Case Study Area – 10km Extension
Green Structure connections to Regional Greenbelt Structure in Black

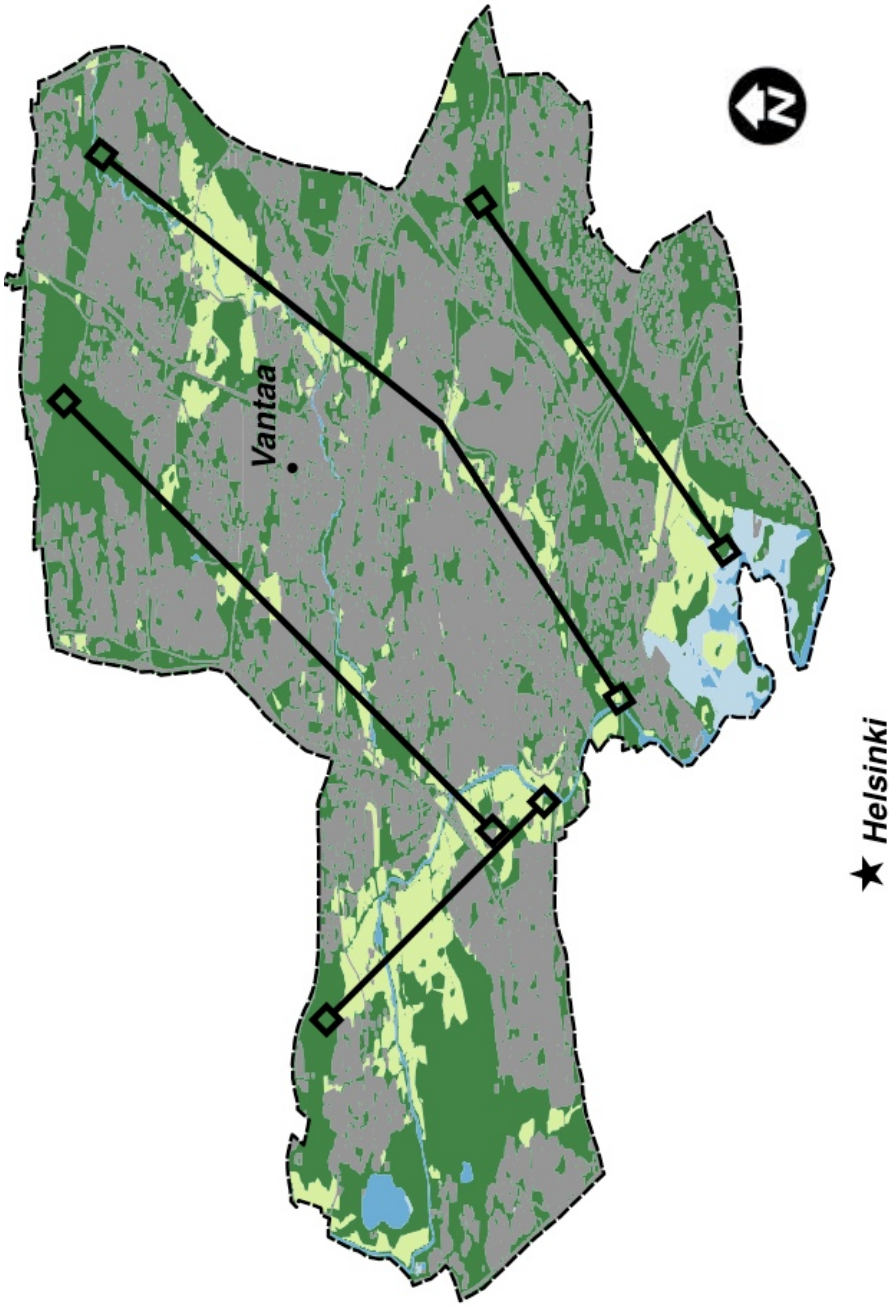


Figure 8.69
Vantaa, Finland Case Study Area
Green Structure Connections in Black

8.4.3 Case Study Spatial Landscape Analysis Results Summary: Green Space and Green Structure Comparison

As shown in Figures 8.66 and 8.68, both regions are surrounded by primarily rural green structures - a green belt. It is how the CAs physically connect internally to their green belts that is different, however. The Vantaa CAs green fingers extend beyond its boundary designation to create a physical connection from the urban centre of Helsinki through the CAs 'Green Fingers' to the larger green belt beyond the peri-urban areas. Conversely, the Paisley CA's GS do not provide a physical connection to the urban centre of Glasgow, although they do connect to the larger green belt beyond the peri-urban areas.

The existing GS in each PUR and CA results from the interaction of natural and human processes over time, resulting in a diverse set of GS characteristics that exist today. Three distinct layers of GS based on their spatio-temporal emergence were observed:

1. Pre-Urban Green Structure Layer,
2. Urban Green Structure Layer,
3. Infrastructure Layer.

Pre-Urban Green Structure Layer

The pre-urban GS layer includes the natural and cultural landscapes that existed prior to urban development. These GS include rivers, forests, wetlands and grasslands. These green structures include many varied vegetation types that reflect the local natural conditions such as soils, geology and historic land use (i.e. farming) practices in each case study area.

It is particularly this pre-urban layer that distinguishes the GS from one CA to the other. For instance, in the HUR, woodlands, wetlands, granite outcroppings and the shoreline are prominent and have influenced the pattern of urban development, similar to Oslo. In the GGUR, on the other hand, open farmland is much more important around the sub-centres. This pattern is similar to other European cities including Utrecht, Munich and Vienna.

Natural features such as hills, rocky outcroppings and, in particular, rivers and streams, often have a special role in establishing connected GS within a region;

this is particularly true for the CAs. These structures establish development constraints that limited urbanisation: it is the steep hillsides, rocky formations, valleys and waterways that have excluded human development and established the central green structure in the two CA: the 'Green Fingers' in the HUR and the two larger structures in the GGUR - Pollock Country Park and the GS encompassing Ralston Golf Course.

In the HUR, the landscape is dominated by glaciofluvial activity leaving exposed bedrock and forested hills alternating with flat, clay areas which once constituted the seabed. Helsinki's city centre is situated on a rocky peninsula near the open sea whereas, inland, the landscape contains rolling granite hills (30-60m above sea level), and woodlands now cover the slopes of these hills. These factors, and the extensive shoreline, focused northward urban expansion, but the significant morphological structure of the 'Green Fingers' remain free from development due to a mixture of former agricultural river valleys, rocky forested ridges with spruce swamps and other wetlands, that have proved geo-technically difficult for construction **(**Vähä-Piikkiö and Maijala, 2003).

In the GGUR, the environmental constraints were not so direct, yet the waterways and hills remained mostly undeveloped. Pollock Country Park was a former estate donated to Glasgow Council but includes a diverse ecological landscape including many water structures. White Cart Water is a strong presence in both the CA's two central green structures.

In both CAs, where natural constraints were not so strong, and where no special protection existed, such as hunting forests, the pre-urban landscape was mostly built over, and remnants of the pre-urban landscape are therefore now fragmented. For instance, in the PUL surrounding Paisley, the GS have been subdivided into many smaller spaces, often smaller than 5ha, including agricultural areas, woodland and grasslands. In Vantaa, many of the smaller streams have been canalised or culverted underground.

The dominance of the biophysical or natural landscape is characteristic for Finland and Scotland. In Finland, almost 75% of the land area is covered in forest (http://www.metla.fi/metinfo/sustainability/finnish.htm); in Scotland, where forests

are mostly an anthropological introduction, it is the agricultural land (i.e. arable) and grassland that make up almost 52% of the land area (http://www.macaulay.ac.uk/explorescotland/lcs_mapformat.html).

Interestingly, the first GS in each CA were undevelopable lands; most of which remain today. The GGUR developed further GS in response to the dense and unsanitary conditions created by the industrial revolution, whereas the HUR had purposeful goals for the provision of GS to its citizens.

Urban Green Structure Layer

The urban green structure layer includes public parks, civic plazas, playing fields, cemeteries but also the GS within the different land uses such as gardens in residential areas, GS on institutional grounds and in commercial developments, as well as land where the former use was abandoned (i.e. derelict land). The distribution of these GS follows the urban development patterns. As in most European industrialised cities, the GS land use is very low in the densely built areas of the urban centre and the 19th century suburban extensions (e.g. Paisley and Vantaa) but somewhat higher in the low-density housing areas. Small urban surface waters (e.g. streams and ponds) exist throughout both CAs and are part of the larger water-based infrastructure, although this complete system is often not visible.

Infrastructure Layer

Infrastructures such as major roads, railway lines and canals can include important GS. Canals are very important in both catchment areas as linear GS. Although the Paisley CA and larger GGUR have many canals and lochs utilised for transportation, only a handful of transportation canals are interspersed within the Helsinki urban centre. The railway lines, meanwhile, may not be accessible but they kept land from being built over within the city. These structures offer some realised opportunities for creating GS corridors when the railways and adjacent land are no longer needed. Large GS can also be found along motorways, major roads and other linear infrastructures.

Interestingly, though the pre-urban GS and development history may be different between the two CAs and PURs, the current (2016) spatial characteristics, including the forms and patterns, are very similar such as their recent process of

outward, concentric urbanisation leading to separate polycentric nodes and overall urban density. Both CAs contain polycentric sub-centres and PUAs yet are physically connected to their larger urban core. Significantly, these sub-centres, like the other polycentric sub-centres within each conurbation, contain fully functional and independent infrastructure, not just extensions of each Region's existing city centre.

Both CAs are associated with human development occurring from the urban core to the rural areas. Both have peri-urban transitional zones; 'hybrid landscapes' of fragmented spaces with both urban and rural characteristics. As discussed in Chapter 3, this particular transitional PUA is often referred to as the urban fringe, peri-urban region, suburban edge, rural-urban zone, rurban space, exurban area, and many others and contain IntGS, specifically PPUIGS.

The CA's include GS just within the peri-urban 'fringe' zone of the polycentric sub-centres - this is where fragmentation (i.e. spatial heterogeneity; Cushman and McGarigal, 2002) is most acute (PLUREL). These 'fringe' zones and their IntGS are considered a fragmentation 'hot-spot' since these spaces exhibit neither fully rural nor fully urban characteristics; they have recently and are still undergoing the landscape fragmentation processes. It is the landscapes and GS within these peri-urban 'fringe' zones that exhibit the most spatial heterogeneity and morphological diversity. Peri-urban 'fringe' zones with IntGS were delineated in Figures 8.70 thru 8.73).

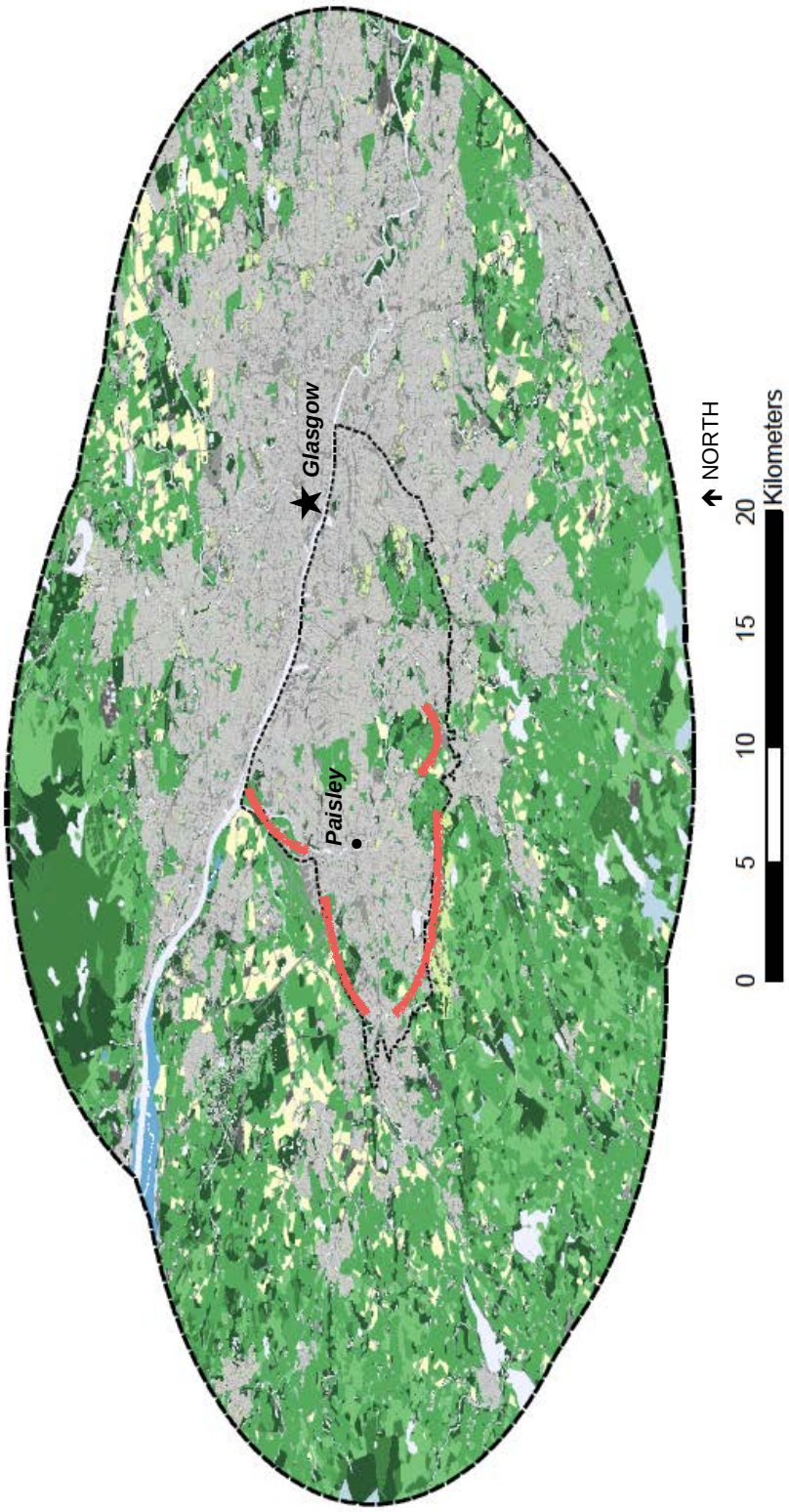


Figure 8.70
Paisley Case Study Area - Peri-Urban Fringe Areas in Red
Scale: Metropolitan
Source: European Nature Information System, Land Cover Scotland 2014

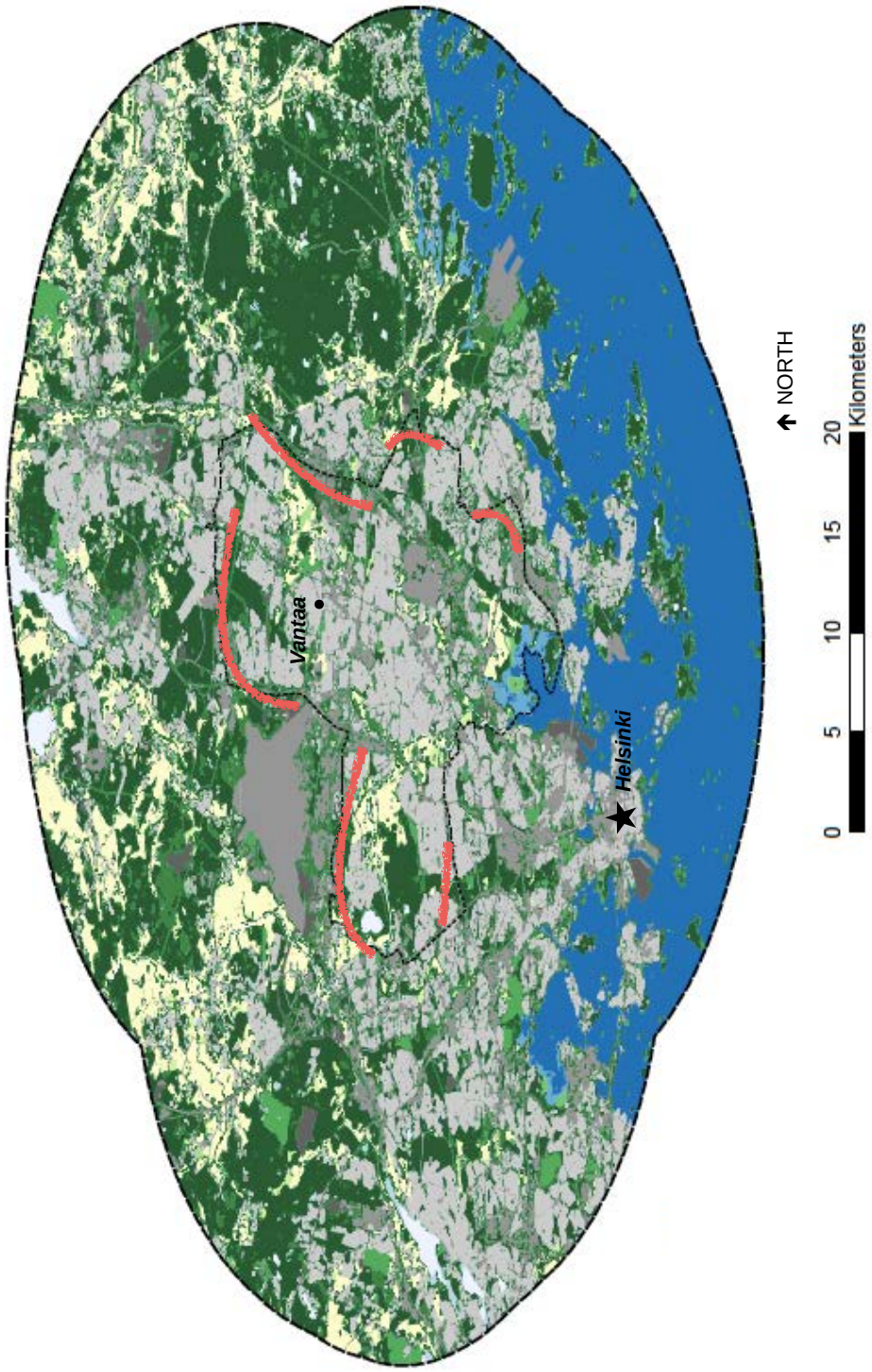


Figure 8.72
Vantaa Case Study Area- Peri-Urban Fringe Areas in Red
Scale: Metropolitan
Source: The European Environment Agency, CORINE Land Cover 2012

Often referred to as ‘urban sprawl’ (EEA) and/or peri-urbanisation (PLUREL), the resultant fragmented landscape is the direct outcome of this suburbanisation process through human development. Both case studies’ PUAs are decentralised, discontinuous, disconnected and segregated (See Table 8.8). It is this diffused urbanisation development pattern that provides peri-urban transitional zones with specific unique qualities that are similar across both CAs, as well as much of Europe:

Decentralisation
Primarily low-density residential land use and strip commercial development to meet the socio-economic demands from an increased population
Discontinuity
Haphazard development patterns and leap-frog patterns where commercial, residential and retail developments are not physically connected or close together
Segregation of Uses
Geographic separation of essential services
(e.g. home, schools, work, hospitals)
Disconnection
Green structures are discontinuous and reduced in size and numbers

Table 8.8
Case Study Area Peri-Urban Characteristics
Both case study areas exhibit similar spatial characteristics due to the process of urbanisation and landscape fragmentation.

There are many similarities in the two case study region’s spatial form regarding polycentric morphology and their urban centres, including their physical size and population density. One noticeable spatial difference exists, however: whereas the GGUR spreads radially in all directions, albeit along existing infrastructural corridors, the HUR is limited in outward expansion by the presence

of Helsinki Bay and the Gulf of Finland, positioning urban expansion only north, east, and westerly of the urban centre.

At the regional scale, the spatial structure and pattern of the HUR's landscape is easier to comprehend; both the GS and the housing developments are readily definable, as are each of the sub-centres. Alternately, the GGUR's regional spatial pattern is less apparent. This is primarily due to the pattern of each region's GS and how they are integrated within the larger matrix of the regional landscape.

The GS form and pattern impact affect the morphology of these two regions through two distinct characteristics: separation and scale. The HUR's urbanised areas – their housing and commercial centres – are clearly separated by somewhat large and interconnected GS, often the 'Green Fingers'. Whereas the GGUR's GS not only are smaller in size, overall, but also less connected to one another.

These characteristics are evident more clearly at the neighbourhood scale (approximately 1:10,000). The HUR's larger and more interconnected GS (e.g. forests) often border housing developments and spatially extend for great lengths within the region (Figure 8.76); conversely GGUR's small and separate GS are integrated into each housing development (Figure 8.77) at multiple scales (e.g. garden plots, small parklets). At both the regional scale (approximately 1:800,000) and neighbourhood scale (approximately 1:10,000), and indeed most other scales, these two GS characteristics – separation and scale – serve to define the spatial pattern of the CAs.



Figure 8.76
Helsinki Urban Region
Morphological Form Impacted through Green Structure Pattern
The HUR's urbanised areas are separated by large and interconnected green structures.
The HUR's larger green structures are often located adjacent to housing developments



Figure 8.77
Greater Glasgow Urban Region
Morphological Form Impacted through Green Structure Pattern
The GGUR's urbanised areas are not clearly separated by green structures; the green structures are small and disconnected to one another.
The GGUR's smaller green structures are often integrated into housing developments

Additionally, each case study region and CA has a unique political and administrative dimension that affects any decision-making process related to spatial planning. Both the UK and Finland function through a centralised government, although the UK experienced more local authority leadership prior to World War Two. The main formal legislative instrument to govern both the GS and urban growth in Helsinki – as well as in every municipality in Finland – is the General Master Plan, which is approved by the municipal council. In the UK system, meanwhile, governance is the process of making decisions that define expectations, grant authority and verify performance, not necessarily managing planning initiatives. In the UK, GS governance and management is commonly a local authority responsibility, often divided between different departments and geographical areas (Britt and Johnston, 2008).

Overall, the CA's GS are in transition from rural to urban, and although they are at various stages of this transition they all share certain physical characteristics: that they are more physically fragmented and spatially heterogeneous than their rural counterparts and exist within a larger PolyPUR.

8.5 Case Study Areas - DPSIR Analysis

The DPSIR framework was utilised to better understand the eco-spatial dynamics of urbanisation and fragmentation within the PPUIGS of the CAs. This analysis provided explicit examples of each component within the DPSIR model, acknowledging contextual variations for each CA and PUL such as specific spatial or landscape characteristics and aspatial or anthropocentric characteristics which influence the current landscape's GS condition (See PESTLE below).

The DPSIR analysis is supported the PESTLE Analysis tool (Chartered Institute of Personnel and Development - CIPD) to look at the main drivers and factors of peri-urbanisation, landscape change and GS fragmentation. PESTLE stands for - Political, Economic, Sociological, Technological, Legal, Environmental and provides a comprehensive set of direct and indirect drivers within a larger DPSIR framework (See Table 8.9).

GENERALISED DRIVERS of URBANISATION within the Case Study Regions	Direct and Indirect

ASPECT	Context of Land Use, Spatial Planning, Landscape Fragmentation, Green Structure
Political	***Planning Policies (e.g lack of planning, development guidance and control)*** *Infrastructure development, Leadership, EU inclusion, War*
Environmental	***Spatial Arrangement and/of Landcover Typologies*** *Rapid urbanisation, Climate change, Resource quality, Degraded urban landscapes*
Social	***Growth (e.g. Urban Migration, Housing Demand, Poor Public Health, Social Mobility)*** *Demographic change, immigration, cultural and religion, ethics, migration*
Technological	***Grey Infrastructure (e.g. Transportation, Housing, Commercial, etc)*** *Car dominance, Knowledge transfer, Technological mobility*
Legal	***Environmental Legislation, Resource Ownership*** **(e.g. Planning Policies & Zoning)** *Urban taxes, Environmental justice*
Economic	***Rural Economic Decline and Employment Opportunities*** *Economic mobility, Lower GDP, Poverty*

Table 8.9
PESTLE Analysis Tool

Case Study Area #1 - Paisley and the Greater Glasgow Urban Region, Scotland

The DPSIR conceptual model (See Figure 8.78) was used in this section to better understand the relationships and interplay between the many GS within the GGURs current PUL and the process of urbanisation and landscape fragmentation.

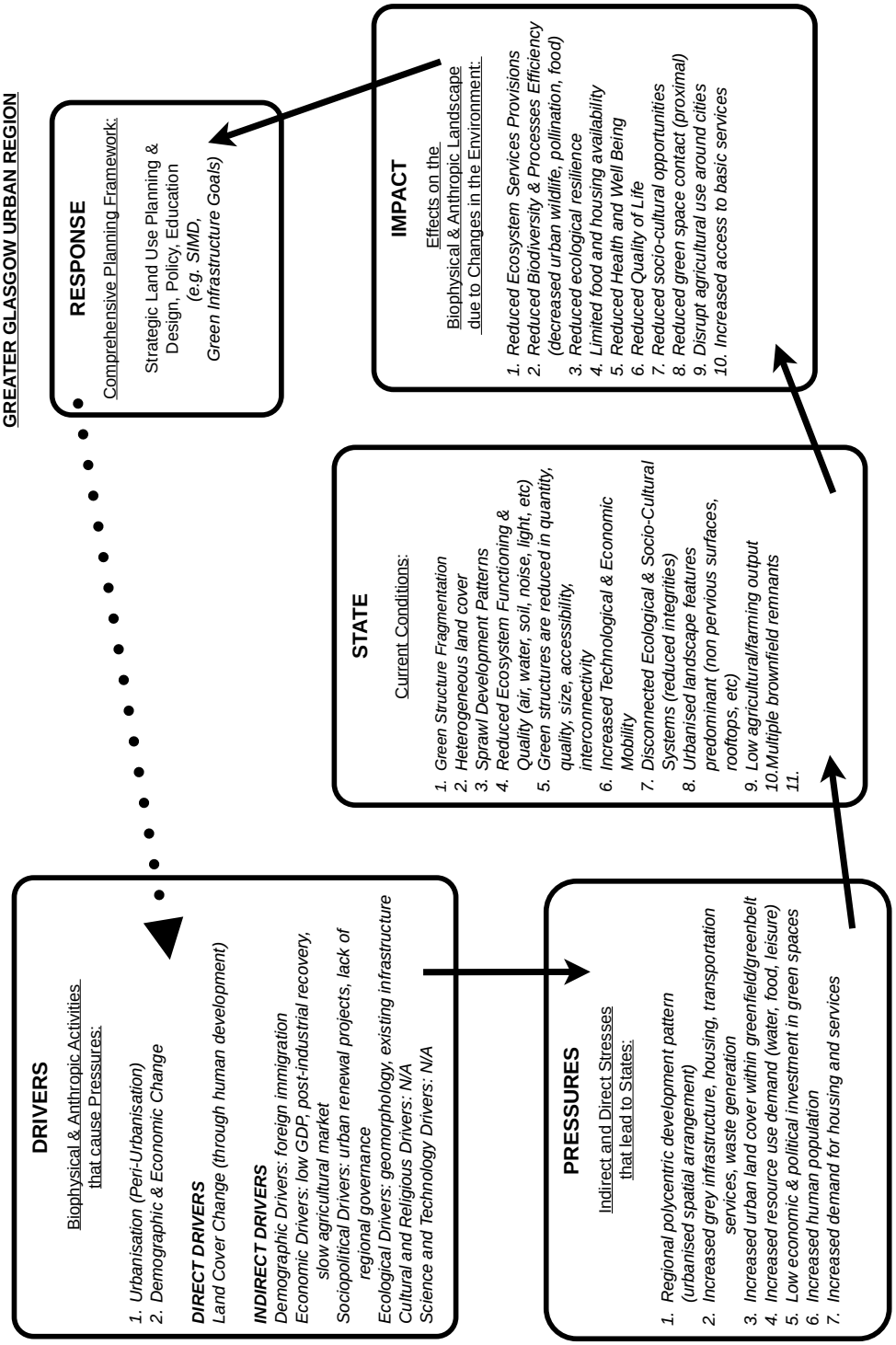


Figure 8.78
DPSIR Analysis Summary Diagram
Greater Glasgow Urban Region

DRIVERS of PUL and GS Fragmentation

The current drivers of the GGURs urban growth and landscape change are many and varied, and include both direct and indirect factors. The direct driver includes land cover change and is discussed in Chapter 3. As land cover is transformed from a rural-based typology to a more urban-based typology, spatial change is direct.

Indirect drivers in the GGUR include demographic and economic change. Foreign immigration was greater than internal migration since 2001 but both added to the region's population size (Understanding Glasgow, 2014).

The GGUR is still recovering from its post-industrial economic decline. In 2004 the GDP per capita of Glasgow city stood at GBP 17,000, which was 73 percent of the average Glasgow metropolitan level (Pallagst et al., 2013). Recent efforts to attract private businesses and maintain service sectors (OECD, 2002) within the City Centre through renewal projects, particularly along the River Clyde, have shown moderate success. Regionally, though agriculture has remained steady, it is believed to have a decreasing economic future (METREX Conference Barcelona, 2004) for the Region.

Additional indirect drivers of spatial change within the GGUR include institutional or socio-political factors such as land use decisions. Though no operational military bases exist within the GGUR, a significant land use driving the location of urban development is the Glasgow Airport and the Clyde Murishiel Regional Park just beyond the peri-urban areas. Inner city renewal is a relatively recent spatial planning program for Scotland and Glasgow. On 12 May 1976, Secretary of State for Scotland Bruce Millan announced the cancellation of the plans to expand the village of Stonehouse outside Glasgow into a New Town of 40,000 inhabitants, and the redirection of the corresponding funds to the Glasgow Eastern Area Renewal (GEAR, 1990). This policy thus put an end to future large-scale developments within the greenfield around Glasgow, though this did not prevent further urbanisation and landscape fragmentation impacts within the greenfield and PUAs of the GGUR. From a regional governance and planning view, it is interesting to note that until 20 January, 2015, no single municipal

government oversaw the GGUR's varied, individual local authorities. Prior to the newly established combined Glasgow and Clyde Valley Cabinet (GCVSDPA, 2009), only strategic decisions were made within these Eight (8) authorities, but no enforcing of spatial planning actions.

Ecological factors within the GGUR has impacted spatial change through indirect means. For example, the airport construction within the GGUR has disrupted hydrological systems to a degree that once arable land became unfarmable (Maantay, 2013). The topography of the GGUR is considered an indirect driver of landscape change as it influences the dynamics of how developed areas expand within the region, particularly differences between uplands and lowlands. The River Clyde and White Cart Water has placed limits on human development opportunities.

From a historical perspective, the irregular glacial topography and resultant wetlands have limited the urban development of central Glasgow (Whitbread and Arkley, 2013), placing additional pressures on other areas within the GGUR.

Though no quantitative data existed on religious and cultural drivers (i.e. values and beliefs) or technological and science drivers (i.e. knowledge and technology diffusion – OECD) of GS spatial change within the GGUR, these factors may cause pressures upon the landscape in subtle indirect means and should be explored in future research as required.

PRESSURES of peri-urban landscape fragmentation

The GGUR is undergoing continued urban expansion as expressed through the human development process, and most of this expansion occurs within the PUAs and their polycentric conurbations and is exhibited through low density land use change. This urbanisation has put more pressure on the existing infrastructure as well as the remaining undeveloped land, often greenfields or green structures, found within the peri-urban landscape. GS as resources have additional utilisation pressures put on them with the rise in population; increased population equates additional demand for the GGUR's GS for food and agriculture, water and energy provision, recreation and leisure activities, and ecological processes such as clean air and water, among others. For example, increased urbanisation of the GGUR

elicits greater surface water run-off into the region's wastewater and hydrological network (Scottish Water, 2015)

The GGUR's urban expansion into the peri-urban, rural, and interstitial areas is expressed through additional infrastructure including roads, residential housing, hydrological management, and waste coordination. Urbanisation requirements ultimately change the land cover within the GGUR, placing pressure upon the socio-ecological landscape and its GS to progressively change states from a more rural and naturalistic condition to urban.

STATES of of PUL and GS Fragmentation

The current state of the GGUR's PUL is one in transition. And the various GS present exhibit various states of this transition, but they all do share some physical characteristics: physically fragmented within a larger spatially heterogeneous socio-ecological, hybridised landscape. It is the state of the socio-ecological systems present which provides the spatial characterisation to the GGUR's peri-urban landscape and its associated green spaces that is the focus of this research.

The current state of the GGUR's PUGS is spatially fragmented, this has been supported, and the resultant morphology is heterogeneous. For example, the topography and urban morphology of the GGUR's PUL and its GS has been altered to accommodate increased urbanisation (e.g. grey infrastructure, canals, dams, riparian modifications). As a result of the drivers and pressures discussed, development in the green belt around Glasgow has occurred (e.g. Newton Mearns) and is expected to continue. Additionally, in 2013, Paisley demolished a 1.2 ha urban park at the corner of Bridge Street and the A726 Mill Street and converted it into a car park (http://www.paisley2020.org/).

IMPACTS of PUL and GS Fragmentation

The current state of fragmented PUGS within the PUL impacts the GGUR and beyond through the concept of landscape services. This eco-spatial fragmentation has led to wider impacts upon the larger ecosystem; it has disturbed in the ecological state of the many socio-ecological systems present. Specifically, fragmentation has impacted ecological processes within the landscape and the GS's

ability to provide a wide range of benefits, both anthropological and biophysical based.

These impacts include changes in the quantity and quality of the various environment elements in the biophysical landscape (soil, water, plants, animals, etc.) and their consequent ability to support the demands placed on them (i.e. environmental functioning and their ability to support human and non-human life) – in other words, the state of the ecosystem and its ecosystem services.

However, within the socio-ecological PUL's transitioning into a more urban state, some impacts are more anthropocentric. Landscape fragmentation produces societal and economic impacts, such as household mobility, segregation, changing economic environments, modified agricultural activities and transportation patterns (Hall 1998). This aspect is exemplified in the GGUR through many elements including additional roads, tram rail, and bridge construction as well as housing, academic, and private sector developments (e.g http://www.paisley2020.org/; https://www.taylorwimpey.co.uk; http://www.scottishconstructionnow.com). These impacts may be considered positive to humans, enabling access to services such as hospitals and shopping as well as reducing poverty and increasing safety. This urbanisation also impacts HWB through access to leisure activities, sometimes within GS. The urbanisation process in the GGUR has not always been upon greenfields; for example, the ongoing (2016) Clyde Waterfront regeneration project (www.clydewaterfront.com) accounts for over 200 urban renewal projects, most upon disused brownfield sites along a 20km stretch of the Clyde River near Central Glasgow.

Landscape fragmentation caused through urban development can also increase species richness and biodiversity within GS as shown in the semi-natural woodlands of Clyde Valley and the transportation networks within the GGUR (SBS, 2007).

RESPONSES of PUL and GS Fragmentation

The current responses are those actions in response to the discussed drivers, pressures, state changes and impacts resulting from urbanisation within the GGUR. These may be technical and institutional or involve policies and planning. They can

be implemented by a range of actors and include various strategies and intervention measures, mostly coordinated by the Government including the UK, Scotland, Councils, and local municipalities.

Natural England and Public Health England have developed green space distance standards modified from the Bristol City Council's accessible green space standard (2008). In this recommendation, GS should be located within a 5 minute walk from every resident within new housing developments. Many municipalities within the UK have adopted similar strategies.

Additional governmental reports have been developed which address specific socio-economic impacts such as poverty (Scottish Index of Multiple Deprivation (SIMD) 2012 Glasgow) or technical actions such as water quality (Drinking Water Quality in Scotland 2010 Annual Report by the Drinking Water Quality Regulator for Scotland) and greenspace strategic development (e.g. Glasgow & Clyde Valley Green Network, 2015; Greenspace Strategy, 2008)

The GGUR will continue to grow outwards from its central core, probably in low-density form, as the weak economic climate of Glasgow limits significant urban densification (Strano et al., 2010).

Case Study Area #2 - Helsinki and the Helsinki Urban Region, Finland

The DPSIR conceptual model (See Figure 8.79) was used in this section to better understand the relationships and interplay between the many GS within the HURs current PUL and the process of urbanisation and landscape fragmentation.

Figure 8.79
DPSIR Analysis Summary Diagram
Helsinki Urban Region

DRIVERS of PUL and GS Fragmentation

The current drivers of the HUR's urban growth and landscape change are many and varied, and include both direct and indirect factors. The direct driver includes land cover change and is discussed in Chapter 3. As land cover is transformed from a rural-based typology to a more urban-based typology, spatial change is direct.

Indirect drivers in the HUR include demographic and economic change. Overall, in Finland, migration occurs from countryside into cities, particularly from northern, forested areas to the urban centres of Southern and South-Western Finland (i.e. the Helsinki Urban Region and it's sub centres) (Karjalainen 1989). The HUR became a global city focusing on technology in the mid 2000's bringing many jobs to the area requiring skilled labor. Though minimal foreign migration took place since 2000, internal migration from the rural regions of Finland was noticeable. Conversely, external migration due to ageing population and agricultural reduction saw this population movement somewhat balanced.

In 2012 the GDP per capita of the City of Helsinki stood at EUR 47,000, which was 133% percent of the average Finland level (OECD Regions at a Glance, 2013) The HUR generates almost 37% of the country's GDP (ibid). The HUR sees private technology sectors drive a strong international trade. Persons aged 19-24 migrate to Helsinki to fulfill the high service, business sector, and technology jobs. They find housing in both suburbs and inner city.

Additional indirect drivers of spatial change within the HUR include institutional or socio-political factors such as land use decisions. The government provides tax subsidies for commuting from more rural areas within the HUR and beyond; efficient infrastructure exists and is managed.

Though no operational military bases exist within the HUR, a significant land use driving the location of urban development is the Ilmala Railway Station in northern Helsinki that serves commuters and is a large depot, and the Vantaa-Helsinki Airport just beyond the PUAs.

Ecological factors can impact spatial change through indirect means. The topography of the HUR is considered an indirect driver of landscape change as it

influences the dynamics of how developed areas expand within the region. The consistent waterfront presence focuses growth north. The Vantaa River and many shoreline wetlands has placed limits on human development opportunities

From a historical perspective, the geofluvial topography and resultant shallow bedrock have limited the urban development in many places, placing additional pressures on other areas within the HUR.

Though no quantitative data exists on religious and cultural drivers (i.e. values and beliefs) or technological and science drivers of GS spatial change within the HUR, beyond their strong economic presence, these factors may cause pressures upon the landscape in subtle indirect means and should be explored in future research as required.

PRESSURES of PUL and GS Fragmentation

The current pressures of the HURs PUGS are many and varied, and include both direct and indirect factors. The HUR is undergoing continued urban expansion as expressed through the human development process. This urbanisation has put more pressure on the existing infrastructure as well as the remaining undeveloped land, often greenfields or GS, found within the PUL. These GS are competing with agricultural and horticultural activity.

In the HUR, as in many European urban regions, the recent trend in life styles and land-use is that single and semi-detached houses being built at a further distance from city centres, resulting in longer commuting distances and service travels (Helminen and Ristimaki, 2008). Consequently, urbanised areas have a higher per-capita area per inhabitant (EEA, 2006).

The HUR's urban expansion into the peri-urban and rural areas is expressed through additional infrastructure including roads, residential housing, hydrological management, and waste coordination. These requirements ultimately change the land cover within the HUR, placing pressure upon the socio-ecological landscape to progressively change states from a more rural and naturalistic condition to urban.

STATES of PUL and GS Fragmentation

The current state of the HUR's PUL is one in transition. And the various GS present exhibit various states of this transition, but they all do share some physical

characteristics: physically fragmented within a larger spatially heterogeneous socio-ecological, hybridised landscape. As a result of the drivers and pressures discussed, particularly urban consolidation and densification, development adjacent to the green fingers, i.e. wedge development, is expected to continue.

IMPACTS of PUL and GS Fragmentation

The geographical expansion of urban areas due to these pressures has resulted in the fragmentation and isolation of PUGS from the rural green areas (Vare and Rekola 2007). Furthermore, these land-use and land-cover changes have had a negative effect on the biological diversity in urban areas (Heikkinen, 2007). Large clearcuts within forests and road construction are two noted impacts upon the GS due to increased urbanisation (Vare and Rekola 2007).

RESPONSES of PUL and GS Fragmentation

Most responses are actions undertaken by the local and national government through policy and planning. The Finnish Constitution of 1917 states that the public (civilians) is responsible for the Country's cultural heritage, the environment and nature. Furthermore, public authorities shall safeguard the public's right to a safe and healthy living environment and the opportunity to affect it's decision making process. The Finnish Planning System is a Three Stage Planning System that operates on a regional and municipal level. The Land Use and Building Act of 2000 only encourages 'sustainable development'.

Finland manages its urban growth in the HUR by promoting low-density development to maintain the rural character, as opposed to the City of Helsinki's inner densification. The Helsinki Green Areas Strategy within the Helsinki Master Plan will bring together three distinct green space concepts: recreation and wellbeing, city identity, and ecological sustainability. These planning projects include continuing urban densifications within the city's core and harbour redevelopment while maintaining existing green structures.

In 2007, the City Council approved a storm water strategy intended to improve the 'eco-efficiency' of water and air cleaning. In 2008, the Helsinki City Planning Department approved the relocation of the commercial harbor to Vuosaari, creating an important publicly accessible shoreline with mixed

development. Helsinki's Strategy Program for 2009–2012 continues urban consolidation through infill development but strives to maintain the green spaces through the Open Space Strategy for Helsinki and is currently (2016) in operation through the Environmental Office of the Helsinki City Planning Department.

The Government has initiated 'return migration' campaigns in Eastern Finland and Lapland, which are notable migration loss areas. This scheme intends to attract the people who have migrated to the growth centres to return back to their roots. The nature and countryside culture and a desire to give the children safer growing environment have been noted as pulling factors. (EVA, 1999). Though the scheme continues (2016), it has been met with minimal success, thus negligible influence on regional development patterns. The HUR will continue growth outwards to the north, probably in low-density form, since urban densification will occur within the City of Helsinki boundaries.

8.6 Case Study Areas - Spatial Analysis Sumary

This Chapter provides a comparative summary of each case study, their CAs and the HURs and GGURs physical landscape and the GS spatial analyses including notable commonalities and differences in the results of the analysis. A comparative spatial analysis of this research's CAs is important for two reasons:

- to better understand the current spatial context and characteristics (i.e. physical form) of each region, specifically landscape fragmentation, spatial heterogeneity, polycentric morphology, and green structure;

- to comprehend the evolution of each region's physical environment (i.e. polycetric peri- urban region) and green structure in order to provide insight into the phenomena and relationships of their spatial development.

As shown, particularly through the DPSIR models, the current pattern of peri-urban landscape fragmentation within the two case studies is the result of a combination of biophysical and social influences, including population dynamics, transportation, institutional factors and topography, which are the primary drivers of land use and spatial change.

In both case studies, the most direct and significant driver of urbanisation is population increase or population relocation. The HUR is currently experiencing migration from the rural parts of Finland, together with external migration, whereas the GGUR is mostly affected by internal migration – individuals relocating from the central urban cores such as Glasgow to the more peri-urban areas of the GGUR. Both regions' populations are increasing at a slow but steady rate. In the HUR, the main in-migration flows in 2000 came to Helsinki from Espoo (5004 persons) and Vantaa (4474 persons) and the highest out-migration flow from Helsinki was directed to Espoo (6017 persons) and the second highest to Vantaa (5255 persons) in Finland. Overall, this is a slight positive migration balance to the City of Helsinki (Heikkilä and Järvinen, 2002).

The spatial landscape analysis examined the specific physical characteristics of the case study areas correlated to overall landscape and GS fragmentation through a set of proxies for fragmentation including visual analysis, CORINE land cover analysis, and the FRAGSTATS tool. These findings supports others that the Vantaa 10km is, comparatively, less fragmented and less impacted by urbanisation pressures than the Paisley 10km, however within the smaller CA, it is Vantaa's GS which is more fragmented than Paisley's GS.

The objective of this spatial landscape analysis was not to measure landscape fragmentation or spatial heterogeneity, but rather to *identify* it using reasonable means and methods for a PhD dissertation and then *broadly analyse* and *describe* it in order to confirm and spatially assess its morphological heterogeneity.

This spatial landscape analysis was not a landscape-ecological integrity or ecosystem structure examination; many landscape analysis and ecosystem applications look at function, or processes, primarily to find structure; this analysis did not. This case study analysis was primarily descriptive.

The spatial landscape analysis of the PURs morphology illustrates and confirms that the CAs exist in a state of fragmentation. The spatio-temporal imagery and historical drivers of change provides a clear understanding of how the morphology of the PURs and their polycentric sub-centres has changed over time. The DPSIR analysis comprehensively summarises the spatial analyses including

some anthropgenic factors specific to spatial change to the landscape's patterns, forms and processes (i.e. functions). In the context of this research, the GS have been reduced in size and quantity and the non-pervious land cover has increased through human development patterns. It is the existing state of the CA's GS and their PPUIGS that is of concern within this research and is best summarised in Figure 8.80. This Figure also summarises this Chapter's analysis of the resultant impacts through the concept of landscape services.

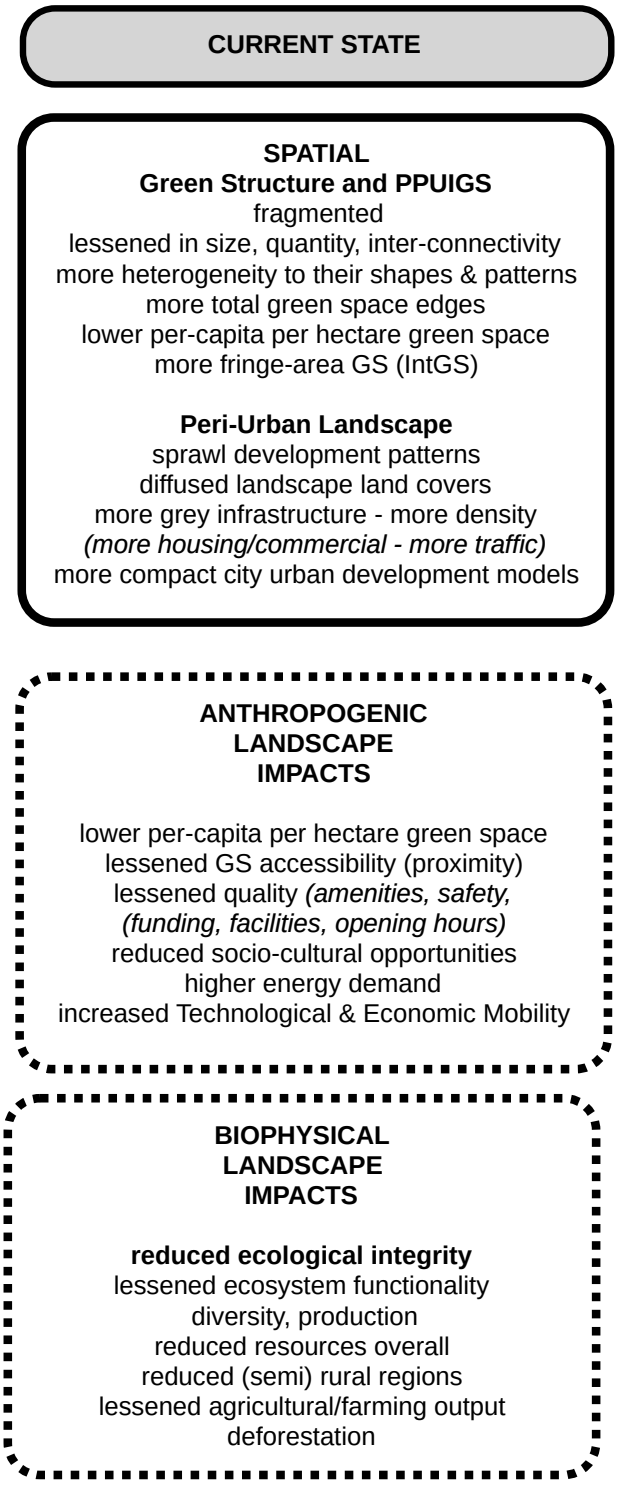


Figure 8.80
Existing State of the Peri-Urban Landscape and their GS and PPUIGS
Case Study Regions

These case study areas were not randomly selected; the data for the key spatial variables of spatial heterogeneity and landscape fragmentation were present in both CAs, and their polycentric-based interstitial peri-urban green structures are considered representative of their larger polycentric conurbation. Furthermore, each CA's primary GS – Vantaa's radial 'Green Fingers' and Paisley's internally-connected green spaces – provide a similar context in which to compare and contrast other variables. For example, within each region's CAs, there is variability in demography, cultural settings and socio-economic influence. Overall, this presents spatially similar yet socially different case studies. It is these spatial relationships, and how the physical context of these PPUIGS influence human behaviour and wellbeing affordances, that requires further examination and is thus of concern in this research.

The case study analysis illustrates the role of PPUIGS – not only as morphological entities that are simultaneously shaping and being shaped by the urbanisation process – but also as explicit and implicit components of the socio-ecological landsdcape (i.e. PUL) present beyond the ecological, including anthropological such as social, political and economic forces, in order to study their relationship to HWB as expressed through the interaction.

Chapter 9 - Results: Case Study Socio-Cultural Landscape Analysis

9.1 Introduction

This Chapter presents the results of the two instruments to collect socio-cultural data including a brief discussion and explanation of those results. The primary data (e.g. geospatial location within the SQ) informed the secondary data collection (e.g. non-structural landscape factors). Overall, this research's primary and secondary data is considered valid and reliable. The results are compared and contrasted between the two case study areas, at multiple scales, providing important relational insights and knowledge specific to this research's questions regarding PPUIGS relationships to HWB. This relationsip is provided through the SQ's operationalisation technique, SoftGIS, which activates Affordance Theory and its transactional paradigm though the collection of the qualitative and quantitative data simultaneously – which specific GS respondents interacted with for what specific HWB benefits.

9.2 Survey Questionnaire Completion Summary

The datasets of both the GS characteristic data identified by the SQ respondents and the SQ response sample sizes varied. Appendix 10 provides a brief discussion and statistics of the SQ completion data for each CA such as visitation and response counts, number of FGS and OGS markers with/without corresponding affordances, and the various initial factor sample sizes based on participation in the SQ. It is important to note that significant data adjustments were required prior to enabling effective sample sizes and statistical analysis (See Section 9.2.2).

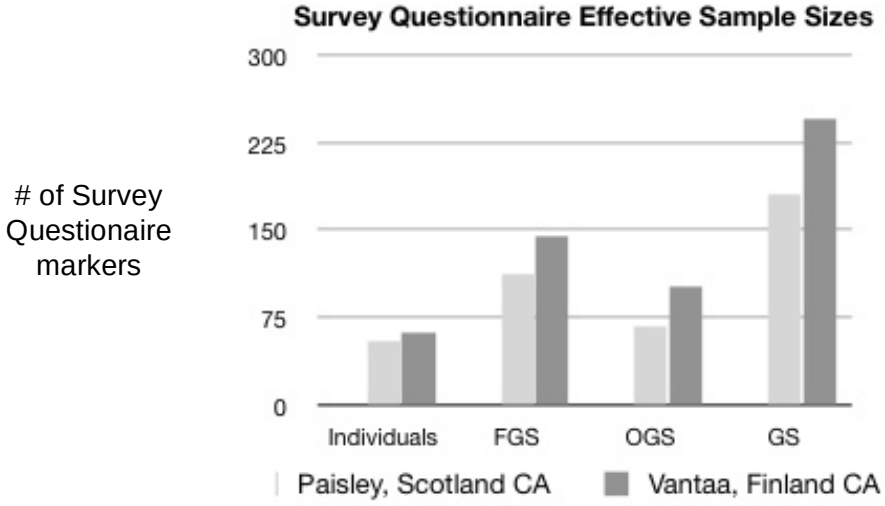
9.2.1 Survey Questionnaire Data Collection and Processing

All collected data was processed using Mapita Software within SoftGIS. All data was coordinated to the respondent number. The results came within Microsoft Excel .csv format but in different contexts. The qualitative data collection (i.e. data that could not be coded) such as the name, address, email, the write-in questions, etc. of the respondents were standard text. The various qualitative participant responses were furnished in the form of coded answers (e.g. 0=yes, 1=no). Lastly,

the quantitative GS goelocations were provided using the geospatial coordinate based format (i.e. N, E). Appendix 11 provides the Survey Questionnaire Metadata collected. Appendix 12 provides the SQ's write-in responses.

9.2.2 Survey Questionnaire Post-hoc Data Adjustments

A series of post-data collection adjustments were made to the SQ datasets to ensure consistent and valid analysis. This 'cleaning-up' of the data included removing incomplete data, respondents, and geomarkers. In addition, some outlier GS markers were removed from the dataset as they were not within the region of study (i.e. CA 10km extension). These are noted in Appendix 13 - Survey Questionnaire Results Post-hoc Data Adjustments and summarised herein. No re-coding of data was completed at this point. Figure 9.1 provides the effective sample sizes for the Individuals (i.e. Individual Factors) and the Landscape Factors (i.e. Aspatial and Spatial Landsape Factors including the HWB Interaction Factors) utilised in the reporting of results and analysis.



	Individuals	FGS Markers	OGS Markers	TOTAL GS MARKERS
Paisley, Scotland CA	55.0	113	69	182
Vantaa, Finland CA	62.0	145	102	247

Paisley, Scotland Dataset

Individual Sample Size	n=55
FGS markers	n≤113
OGS markers	n≤69
Total GS markers	*n≤182*

Vantaa, Finland Dataset

Individual Sample Size	n=62
FGS markers	n≤145
OGS markers	n≤102
Total GS markers	*n≤247*

Figure 9.1
Survey Questionnaire Effective Sample Sizes for Analysis

The Paisley survey questionnaire data collection resulted in 55 unique participants (n=55) which could be analysed, the Vantaa survey questionnaire data collection resulted in 62 (n=62).

An important component of this research's data analysis is that certain aspects of the SQ collected data could be analysed effectively without other sections being completed in full. For instance, though some respondents did not provide their home location or their gender, age, etc., they did provide GS markers and their associated affordances or HWB benefits, thereby providing partial insight into this specific eco-spatial relationship. As such, the sample size for each factor and subsequent analysis fluctuated, though not substantially. The reason that the FGS and OGS markers differ is that all eco-spatial characteristics, structural and non-structural - or spatial and aspatial, could not be evaluated for all GS locations. This did not reduce the validity of the results as this occurred in no more than 5 (+/- 5) markers for any characteristic.

9.3 Research Variables and Variable Diagram

This section provides a descriptive summary and illustration of this research's variables (See Figure 9.2 and 9.3) as collected through the SQ. The variables are simply the same factor groups found within Chapter 6 and Figure 6.2 but expressed herein as a simple diagram in order to understand the data analysis process and functional relations better. All variables are controlled to the best possible degree but in that they are constant and measured and are not manipulated in the study design.

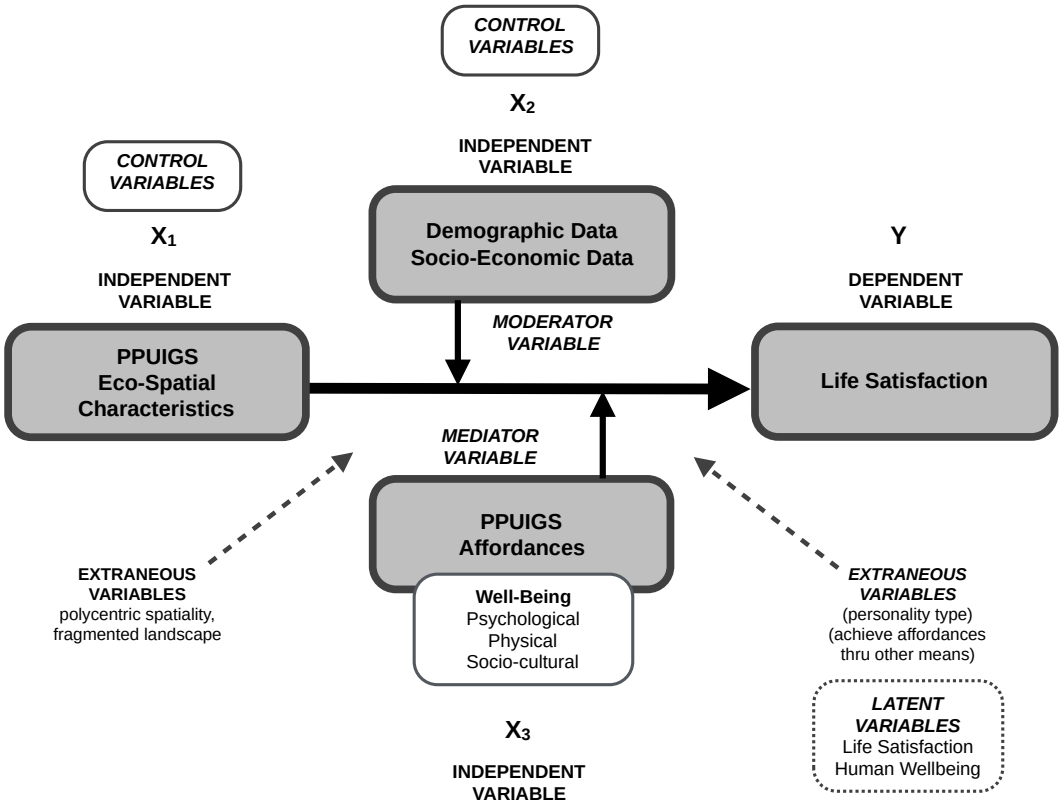


Figure 9.2
Relationship Diagram of Factors Groups
Expressed as Variables

Dependent Variable

Y Life Satisfaction (Self-Reported)

Independent Variables

X1 PPUIGS Eco-Spatial Characteristics (Spatial and Aspatial)

(Structural and Non-Structural Landscape Factors)

- Size, Shape, Proximity, Edge, Accessibility, Level of Green,
- Maintenance and Management, Safety
- Green Structure Profile

X2 Demographic and Socio-Economic Data (Individual Factors)

(Moderator Variables)

- Demographic Factors
- Socio-Economic Factors

These variables serve as moderator variables and affect the strength of the association between X1 (PPUIGS Eco-Spatial Characteristics) and Y (Life Satisfaction).

X3 PPUIGS Human Wellbeing Affordances (HWB Interaction Factors) *(Mediator Variables)*

- Psychological Wellbeing
- Social Wellbeing
- Physical Wellbeing

These variables serve as mediator variables and affect the strength of association or the relationship between X1 (PPUIGS Eco-Spatial Characteristics) and Y (Life Satisfaction).

Control Variables

As far as possible, the following control variables were constant across the study. For X1, variability was reduced by the purposive spatiality of the CAs as fragmented, polycentric conurbations, and other factors discussed previously. For X2, the sample size was also controlled by the geographic location of the survey-questionnaire (SQ) respondents as well as the age parameters (18-75).

Extraneous Variables

Many extraneous variables that are not measured but which may influence the outcomes exist within this study, even with the presence of control variables: these include the spatial condition of the landscape and their GS such as degree of polycentricity and fragmentation, which may vary both within the CA and between the case study regions. The various personality types of respondents also influence LS results. Additionally, respondents may achieve HWB affordances through other means than GS interaction, such as a gym, vacations and travel, work or social groups.

Latent Variables

Latent variables exist within this study, which may not be explicitly observed or measured, such as a respondent's mental state (e.g. depression, bipolar, Alzheimer's) and the many other factors (e.g. cognitive, economic, etc.) that influence LS and HWB unaccounted for within this study's structure.

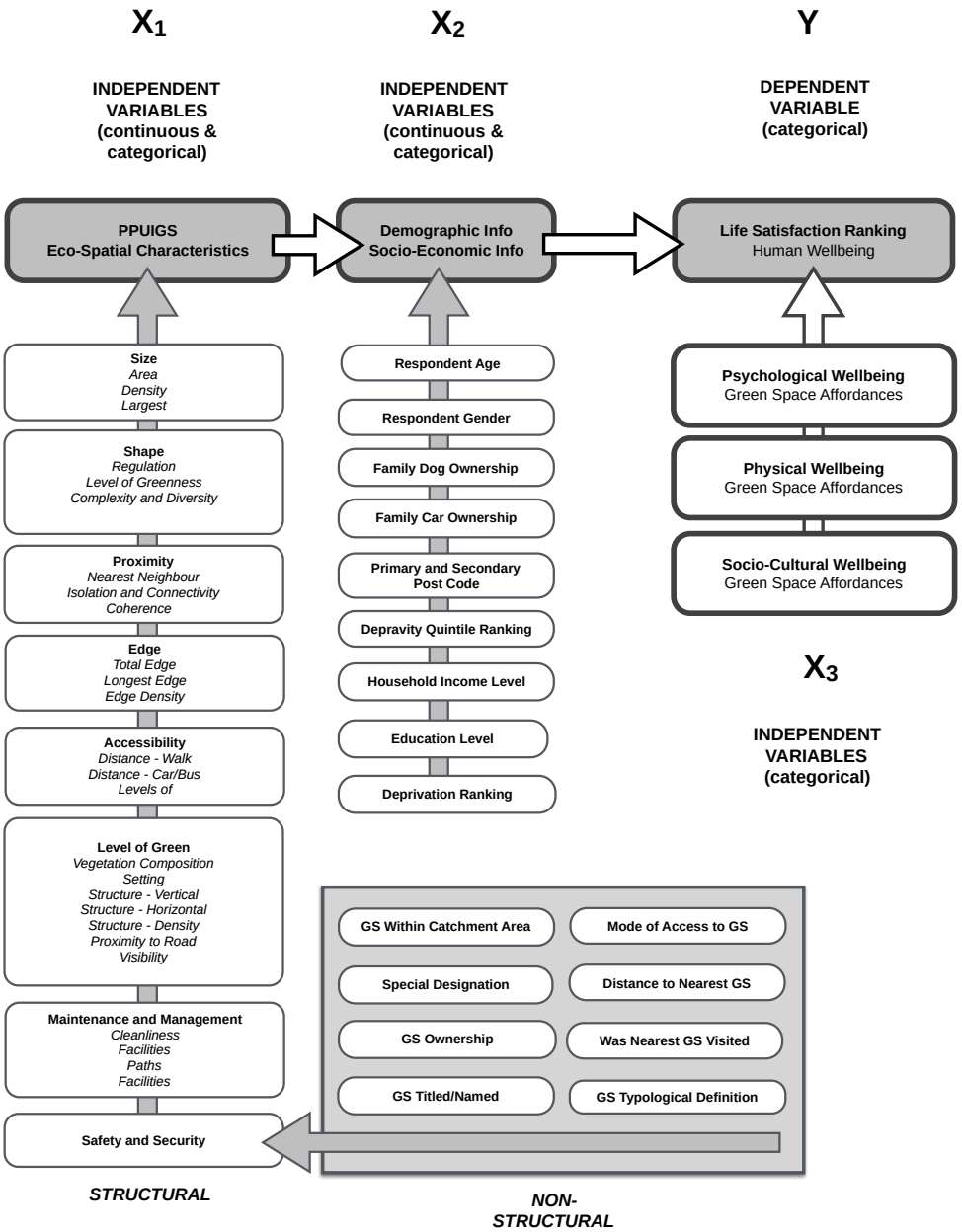


Figure 9.3

Variable Diagram

9.4 Survey Questionnaire Results Analysis Introduction

This section begins the data analysis and interaction included within the statistical analysis of the empirical data for the variables comprising the following steps:

Step 1 – Data Input and Coding
Step 2 – Variable Distribution Analysis
Step 3 – Simple Descriptive Analysis
Step 4 - Factor Analysis
Step 5 –Exploratory Descriptive Analysis (univariate and bivariate)
Step 6 – Multivariate Analysis

The goal for these steps was to increase data comparability across contexts. After the data was codified and synthesised, a normal distribution test was conducted for the variables. The factor analysis utilised the M-H test of linear regression. The descriptive analysis evaluated the data in three distinct characteristic profiles: a profile of the SQ respondents, an eco-spatial profile of the green spaces and green structures (GS), and a profile of the HWB benefits received when individuals interact with those GS. Patterns of GS interaction were thereby explored.

The data analysis also tested for the strength of the relationships between the variables. The multivariate data analysis tested for mediation and moderation utilising the Pearson Correlation Test. Further variable relationships were tested using the Cochran-Armitage Trend Test, focussing on the results of the 2-Sided P-Test for trends in association.

Step 1 – Data Input and Coding

The first step was to input the data into SPSS (Statistical Package for the Social Sciences) format. The data was analysed using SPSS software version 21. The data was separated into two groups reflective of the SQ's CAs – Paisley, Scotland, and Vantaa, Finland. Though most of the data received from the SQ was in .csv format and could be imported into SPSS directly, some manual data input or transference was required, and this was double-checked for accuracy. In addition, if the data was incorrectly translated or coded within the .csv files, e.g. 0=yes and 1=no, this was re-coded within SPSS. Appendix 15 provides this information in full

detail.

For the following analyses, there were two sets of data, one for each of the two CAs and associated SQ effective samples.

Step 2 – Variable Distribution Analysis

All variables (X1, X2, X3 and Y) were of normal distribution (See Appendix 16). Thus linear regression could be run (See Step 4).

Step 3 – Simple Descriptive Analysis

Simple statistics of the variables for this analysis are found within Appendix 16 and summarised and described in Section 9.5.

Step 4 - Factor Analysis

The next step in the data analysis consisted of a factor analysis of the dependent variable (DV) – life satisfaction (Y) - and the independent variable (IV) - PPUIGS eco-spatial characteristics (X1). This analysis served to identify the predictor variables for regression – i.e. those X1s which affect Y or those PPUIGS characteristics which potentially affect an individual's LS. Results are summarised and described in Section 9.7.

The factor analysis asked *"What are the underlying dimensions of the self-reported life-satisfaction rankings? How do the eco-spatial characteristics of GS inform the relationship to the LS rankings?"*

The factor analysis was conducted using the SPSS software. This factor analysis was a block-wise regression analysis, not step-wise, and did not employ principal component analysis (PCA) due to the number of variables and inherent grouping of those variables. There were two separate stages of factor analysis: an exploratory factor analysis (EFA) followed by a second factor analysis (FA) after the variables were modified.

EFA Results

The exploratory factor analysis (EFA) concluded that no significant variables existed. A full table of these results are located in Appendix 22. This exploratory factor analysis (EFA) utilised the M-H test of linear regression. The cut-off limit for an item to be regarded as a significant contributor to a factor was a loading of at least 0.50. Logistic (block-wise, backward) regression analysis was run to obtain an impression of the impact of GS eco-spatial characteristics on self-reported life satisfaction levels. It was determined that none of the GS independent variables (X1) were significant in predicting LS.

Variable Modification

It was then determined that the data or variables needed to be simplified or grouped into homogeneous sets (i.e. blocks) of variables prior to another FA. This simplification is explained within Appendix 23. The blocking strategy for the landscape factors is shown in Figure 9.4 and was coordinated specific to landscape fragmentation and the similar spatial characteristics within homogenous groups.

X1 – GS Characteristics

Block 1 - (Fragmentation Characteristics)
- a. Edge - Total
- b. Edge - Density
- c. Size - Density
- d. Shape - Regulation
- e. Shape - Complexity and Diversity
- f. Proximity - Nearest GS Neighbour
- g. Proximity - Isolation and Connectivity
- h. Proximity - Level of Coherence

Block 2 - (Maintenance & Safety)
- a. Maintenance & Management
  - Cleanliness
  - Facilities
  - Facilities - Paths
  - Facilities - Sociability
- b. Safety and Security

Block 3 - (Vegetative Characteristics)
- a. Level of Greenness
  - Vegetation Composition
  - Vegetation Density

Horizontal Structure
Vertical Structure
Visibility

Block 4 - (Composition Characteristics)
a. Level of Greenness - Vegetation Composition - Setting
b. Level of Greenness - Proximity to Heavy Traffic Road
c. Shape - Regulation - Greenness Characteristic

Block 5 - (Edge Structure)
a. Edge
Total Edge
Longest Edge
Edge Density

Block 6 - (Size Structure)
a. Size
Area
Density
Largest

Block 7 - (Shape Structure)
a. Shape
Regulation
Complexity and Diversity

Block 8 - (Proximity Structure)
a. Proximity
Nearest GS Neighbour
Isolation and Connectivity
Level of Coherence

Figure 9.4
Blocking Strategy for Data Analysis
(X1 - *Eco-Spatial PPUIGS Characteristics)*

FA Results

A second logistic (block-wise, backward) regression analysis was completed for the blocked variable sets (See Appendix 23 for results). This blocking analysis looked for significant variance within these categories of prediction to LS. Within X1, blocks 1-3 and blocks 1-8 were run separately as shown in Figure 9.4.

Overall, no blocks / no variables were identified as significant predictors of LS. The factor analyses and logistic regressions were performed to provide insights into the extent to which eco-spatial factors of GS and demographic characteristics

illustrate that they could not predict levels of life satisfaction. The independent variables of eco-spatial characteristics (X1), therefore, do not predictably measure or influence life satisfaction (Y). This means that the eco-spatial characteristics of GS (X1) are not directly related to Life Satisfaction (Y), probably because of socio-demographic moderator variables (X2) and HWB affordances acting as mediator variables (X3). Thus, there exists an indirect relationship between X1 and Y.

Step 5 – Exploratory Descriptive Analysis

In order to answer the research questions and provide an exploratory analysis of the variables and factors that provide insight into the relationships, an exploratory analysis of simple statistics was completed focusing on relationshps between factors through crosstabulation statistical strategies. Results and discussion are located withih Section 9.6.

Step 6 – Multivariate Analysis

The multivariate data analysis explored the interactions between the variables and tested the strength of the relationships between them, including their mediation, moderation, statistical significance and associative patterns. The statistical analysis for mediation and moderation tested the causal relationship between variables in which one variable affects a second variable that, in turn, affects a third variable

Testing for Mediation

The statistical analysis for mediation within this research expresses the relationship as follows:

> Is there a relationship between the eco-spatial characteristics of green spaces (X1) and life satisfaction (Y) having accounted for the types of human wellbeing benefits (affordances) they receive when visiting green spaces in the population samples (X3)?

Testing for Moderation

The statistical analysis for moderation within this research expresses the relationship as follows:

Is there a relationship between the eco-spatial characteristics of green spaces (X1) and life satisfaction (Y) having accounted for socio-demographic differences in the population samples (X2)?

Results and discussion are located withih Section 9.7.

9.5 Simple Descriptive Analysis Results Introduction

This descriptive analysis presents the simple statistical results tabulated and compared from the SQ for the various factors within this research:

- Individual Factors

- Landscape Factors (Structural and Non-Structural)

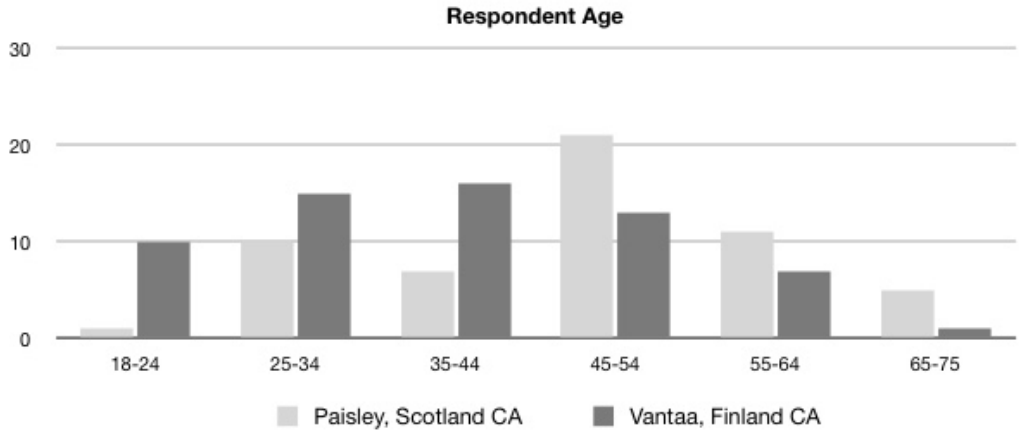
- Human Wellbeing (HWB) Interaction Factors

9.5.1 Descriptive Analysis Results –Individual Factors

This section includes the various demographic and socio-economic characteristics of the respondents. In order to structure this human-nature relationship analysis, the Aspatial Landscape Factors are included herein as they primarily reside within the individual though environmentally contextual.

- Age;
- Gender;
- Dog Ownership;
- Car Ownership;
- Postal Code;
- Household Income;
- Education level;
- Life Satisfaction;
- Poverty Risk Ranking (Vantaa)
- Deprivation Ranking (Paisley).

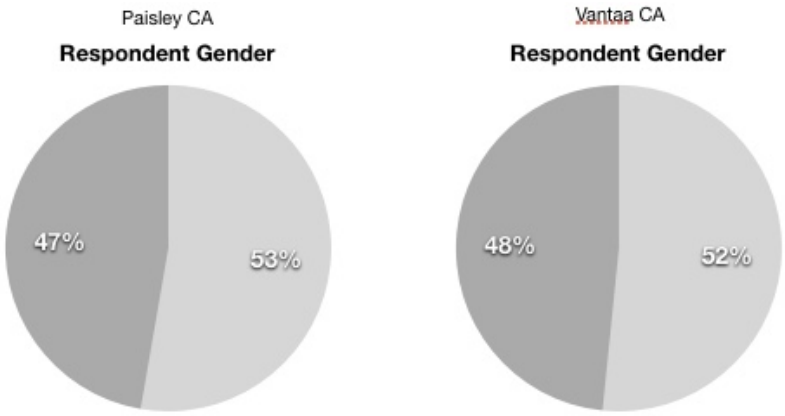
Table 9.1
Descriptive Analysis – Individual Factors



	18-24	25-34	35-44	45-54	55-64	65-75
Paisley, Scotland CA	1	10	7	21	11	5
Vantaa, Finland CA	10	15	16	13	7	1

Paisley CA	**Frequency**	**Age**	**%**
	1	18-24	1.8%
	10	25-34	18.2%
	7	35-44	12.7%
	21	45-54	38.2%
	11	55-64	20%
	5	65-75	9.1%
Vantaa CA	**Frequency**	**Age**	**%**
	10	18-24	16.1%
	15	25-34	24.2%
	16	35-44	25.8%
	13	45-54	21.0%
	7	55-64	11.3%
	1	65-75	1.6%

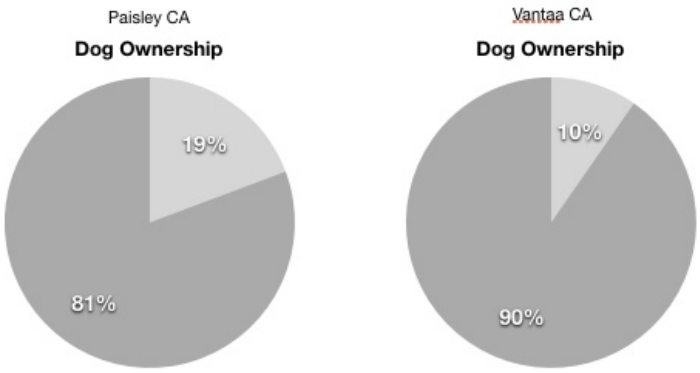
Figure 9.5
Respondent Age Comparison



	Male	Female
Paisley, Scotland CA	29	26
Vantaa, Finland CA	32	30

Gender	**(M/F)**	
Paisley CA	29 Male - 52.7%	26 Female - 47.3%
Vantaa CA	32 Male - 51.6%	30 Female - 48.4%

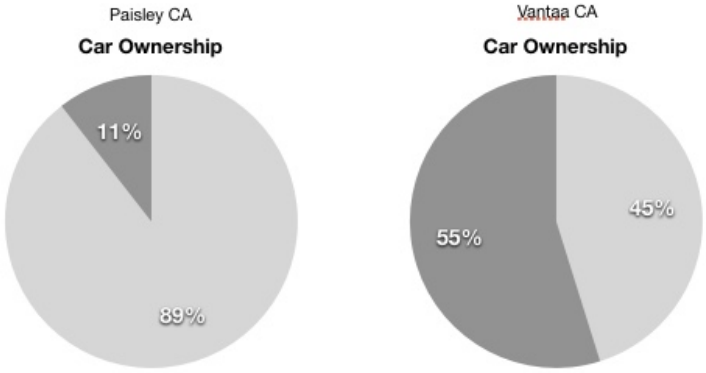
Figure 9.6
Respondent Gender Comparison



	Yes	No
Paisley, Scotland CA	11	46
Vantaa, Finland CA	6	56

Family Dog Ownership (Y/N)		
Paisley CA	46=no	11=yes
Vantaa CA	56=no	6=yes

Figure 9.7: Respondent Dog Ownership Comparison



	Yes	No
Paisley, Scotland CA	51	6
Vantaa, Finland CA	28	34

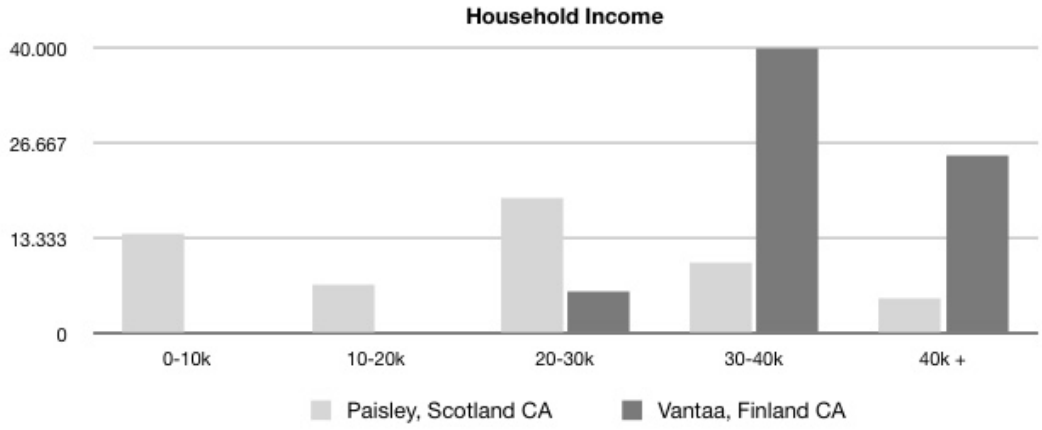
Family Car Ownership (Y/N)		
Paisley CA	6=no	51=yes
Vantaa CA	34=no	28=yes

Figure 9.8: Respondent Family Car Ownership Comparison

The respondents' geo-marked 'Home Location' per the SQ was geocoded and used to determine the secondary data, here the socio-economic data for the respondents, though general to post code regions, not households or individuals.

Paisley CA		
	#1	PA1 (n=10, 18.2%)
	#2	PA2 (n=5, 9.1%)
	#2	PA3 (n=5, 9.1%)
	#2	PA8 (n=5, 9.1%)
Vantaa CA		
	#1	00820 (n=7, 11.3%)
	#2	00780 (n=6, 9.7%)
	#3	4 at 3x (4.8%) 01350, 00240, 00500, 00980

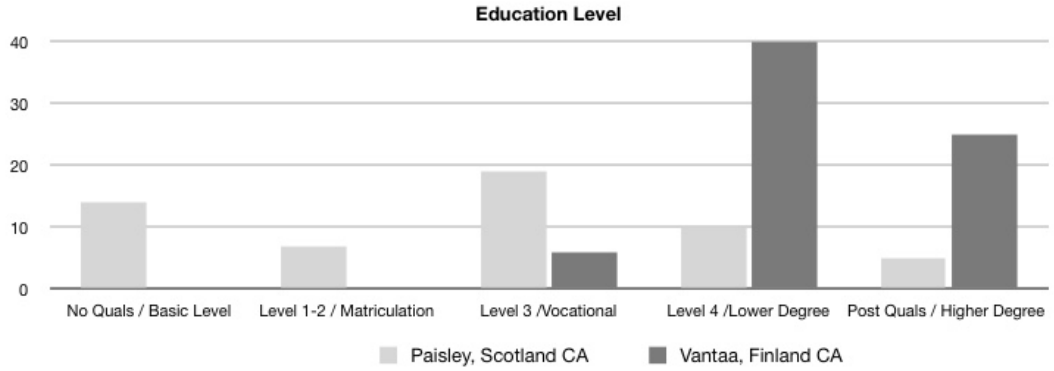
Figure 9.9
Primary Post Code Comparison



	0-10k	10-20k	20-30k	30-40k	40k +
Paisley, Scotland CA	14	7	19	10	5
Vantaa, Finland CA	0	0	6	40	25

Paisley CA			
	0-10,000 BP	14	25.5%
	10-20	7	12.7%
	20-30	19	34.5%
	30-40	10	18.2%
	40+	5	9.1%
Vantaa CA			
	0-10,000 EURO	0	0%
	10-20	0	0%
	20-30	6	9.7%
	30-40	40	65.4%
	40-50	11	17.7
	45-50	9	14.5%
	50-60	3	4.8%
	60+	2	3.2%

Figure 9.10
Household Income Comparison



	No Quals / Basic Level	Level 1-2 / Matriculation	Level 3 / Vocational	Level 4 /Lower Acad Degree	Post Quals / Higher Acad Degree
Paisley, Scotland CA	14	7	19	10	5
Vantaa, Finland CA	0	0	6	40	25

Paisley CA		
No Quals	7	12.7%
SVQ Level 1 or 2	9	16.4%
SVQ Level 3	10	18.2%
SVQ Level 4	10	18.2%
Post Quals	19	34.5%
Vantaa CA		
Basic Level Studies	0	0%
Matriculation Exam	11	17.7%
Vocational Diploma	51	82.3%
Academic Degree - Lower	0	0%
Academic Degree - Higher	0	0%

Figure 9.11
Education Level Comparison

Paisley CA

Deprivation Quinitile Ranking (SIMD threshold levels)

Income 0-5% median 4	7.3%:	
Income 5-10% median	1	1.8%
Income 10-15% median	5	9.1%
Income 15-20% median	1	1.8%
Income 20-100% median	44	80%

Depravity Decile Ranking Scores (SIMD threshold levels)

Income 1-10% median	6	10.9%
Income 11-20% median	3	5.5%
Income 21-30% median	6	10.9%
Income 31-40% median	4	7.3%
Income 41-50% median	3	5.5%
Income 51-60% median	5	9.1%
Income 61-70% median	4	7.3%
Income 71-80% median	0	0%
Income 81-90% median	7	12.7%
Income 91-100% median	17	30.9%

Vantaa CA

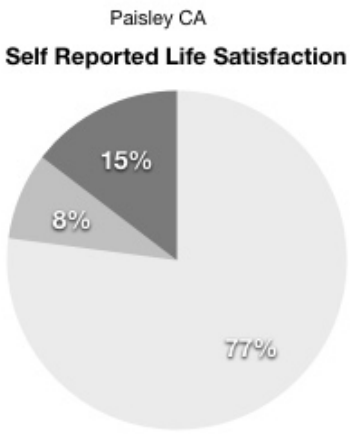
Poverty Level Ranking

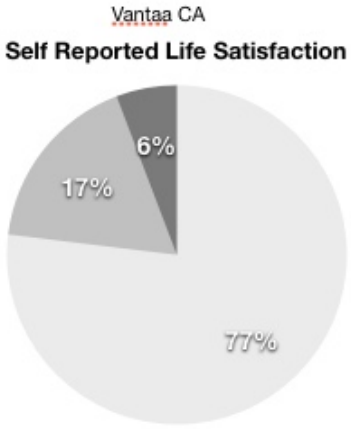
Income 0-40% median	0	0%
Income 40-49% median	0	0%
Income 50-59% median	0	0%
Income >60% median	62	100%

Note: None of the respondents in the Vantaa, Finland SQ reported an income level below the 60% median level.

Figure 9.12
Socio-Economic Comparison

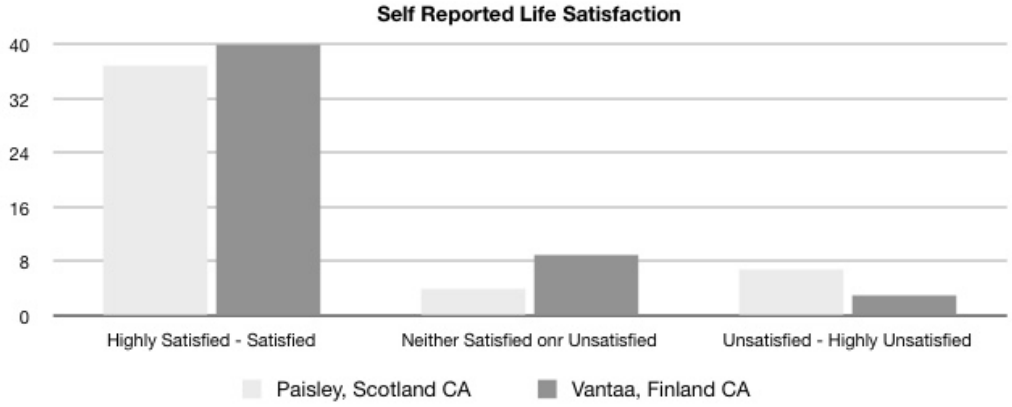
The Paisley SQ highest frequencies resulted in 53% females and 42% of respondents of either gender within the 45-54 age range, whereas in Vantaa, it was 52% male with a 25-34 (25%) and 35-44 (26%) age range. This result does not tell the overall age range and respondent percentages within the entire catchment areas (CA) or region, however: only the SQ respondents. Car ownership, however, is significantly lower in Vantaa, although their mean household income is higher, suggesting it is a conscious choice and not economic.





	Highly Satisfied - Satisfied	Neither Satisfied nor Unsatisfied	Unsatisfied - Highly Unsatisfied
Paisley, Scotland CA	37	4	7
Vantaa, Finland CA	40	9	3

\



	Highly Satisfied - Satisfied	Neither Satisfied nor Unsatisfied	Unsatisfied - Highly Unsatisfied
Paisley, Scotland CA	37	4	7
Vantaa, Finland CA	40	9	3

Paisley CA

Of 55 survey respondents, 48 (n=48) gave their self-reported life satisfaction.

37	were highly satisfied or satisfied	67.3%
4	were neither satisfied nor unsatisfied	7.3%
7	were unsatisfied or highly unsatisfied	12.7%

Vantaa CA

Of 62 survey respondents, 52 (n=52) gave their self-reported life satisfaction.

40	were highly satisfied or satisfied	76.9%
9	were neither satisfied nor unsatisfied	17.3%
3	were unsatisfied or highly unsatisfied	5.8%

Figure 9.13
Self-Reported Life Satisfaction Comparison

This variable had to be grouped and recoded. Within the Paisley CA, 67% of respondents reported a LS level of satisfied or highly satisfied, while within the Vantaa CA, this was 77%. Only 13% of respondents in the Paisley CA reported highly unsatisfied or unsatisfied LS and only 6% within the Vantaa CA. Overall, both datasets provide similar LS rankings and distribution ranges for analysis and summarised below:

Paisley CA

- **Males**
- **Aged 45-54**
- **Do not own a dog**
- **Household does own a car**
- **Live in Postal Code PA1**
- **Live in a household annual income level of 20-30K BP**
- **Live in a household within 20-100% of the median SIMD**
- **Possess a post-qual education level**
- **Reported highly satisfied or satisfied with life**

Vantaa CA

- **Males**
- **Aged 35-44**
- **Do not own a dog**
- **Household does not own a car**
- **Live in Postal Code 00820**
- **Live in a household annual income level of 30-35K Euro**
- **Live in a household within >60% of the poverty threshold**
- **Possess a vocational diploma education level**
- **Reported highly satisfied or satisfied with life**

Table 9.2
Individual Factor Summary and Comparison

9.5.2 Descriptive Analysis Results –Landscape Factors Introduction

This section includes the results of the various Spatial and Aspatial Landscape Factors as collected through the SQ. An abundance of data was collected and synthesized for the FGS and OGS characteristics and factors from the SQ's geomarkers. However for the purpose of data analysis as well as further relationship insight and causal inferences, this descriptive analysis shall focus on the GS results, the combined FGS and OGS as they collected the same types of data. This GS data is considered exemplary of the CA and sample. Any anomalies are noted. The results and analysis for the FGS and OGS of each CA is found with the Appendix 18 and specifically noted in each subsequent section.

Paisley CA
Sample Size: n=182 GS, n=55 individuals
182 individual GS locations (n=182).
57 Unique individual locations (n=57).

Vantaa CA
Sample Size: n=247 GS, n=62 individuals
247 individual GS locations (n=247)
121 Unique individual locations (n=121)

Figure 9.14: Effective Landscape Factor GS Sample Sizes

The structural and non-structural landscape factor results and descriptive analysis within the remaining sections were determined from the GS geomarkers. The spatial results of the SQ's SoftGIS illustrate the geo-located data and when combined with statistical analyses, allowed the production of intensity or 'heat maps'. This research illustrates its geospatial statistical findings utilising intensity maps through two distinct approaches: concentration of geomarkers, or points, and distribution of point values.

The use of heat maps, often referred to as density maps, 'hot spot' maps or cluster heat maps, provides a graphic illustration of the geographic variables and values summarised from this research's analysis and is a statistical analysis technique often utilised in cartography Recently, Esri's (2012) ArcGIS documentation refers to this type of map as a *"point density interpolation"*, however, 'intensity map' is the common term in the GIS and planning disciplines, though heat map may, overall, be more frequently used and more readily understood.

This section’s heat maps help visualise the spatial distribution and frequencies of the various GS geomarkers. Figure 9.15 and 9.17 illustrates both CA’s GS locations expressed as a heat map with individual markers and Figure 9.16 and 9.18 illustrates both CA’s GS and the Home locations. These results include GS locations within the larger PUL - the 10km boundary.

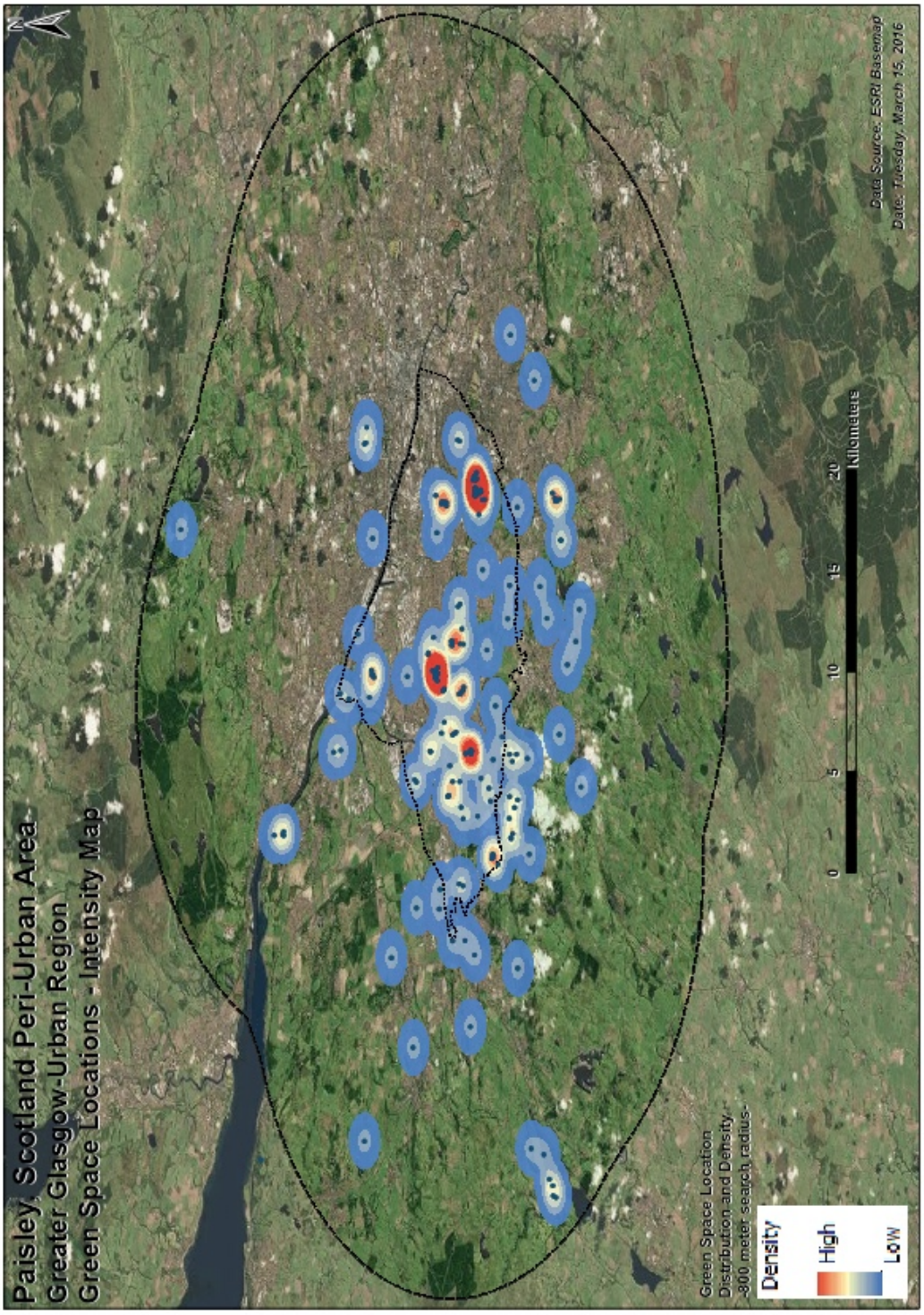


Figure 9.15
GS Locations Heat Map – Paisley CA

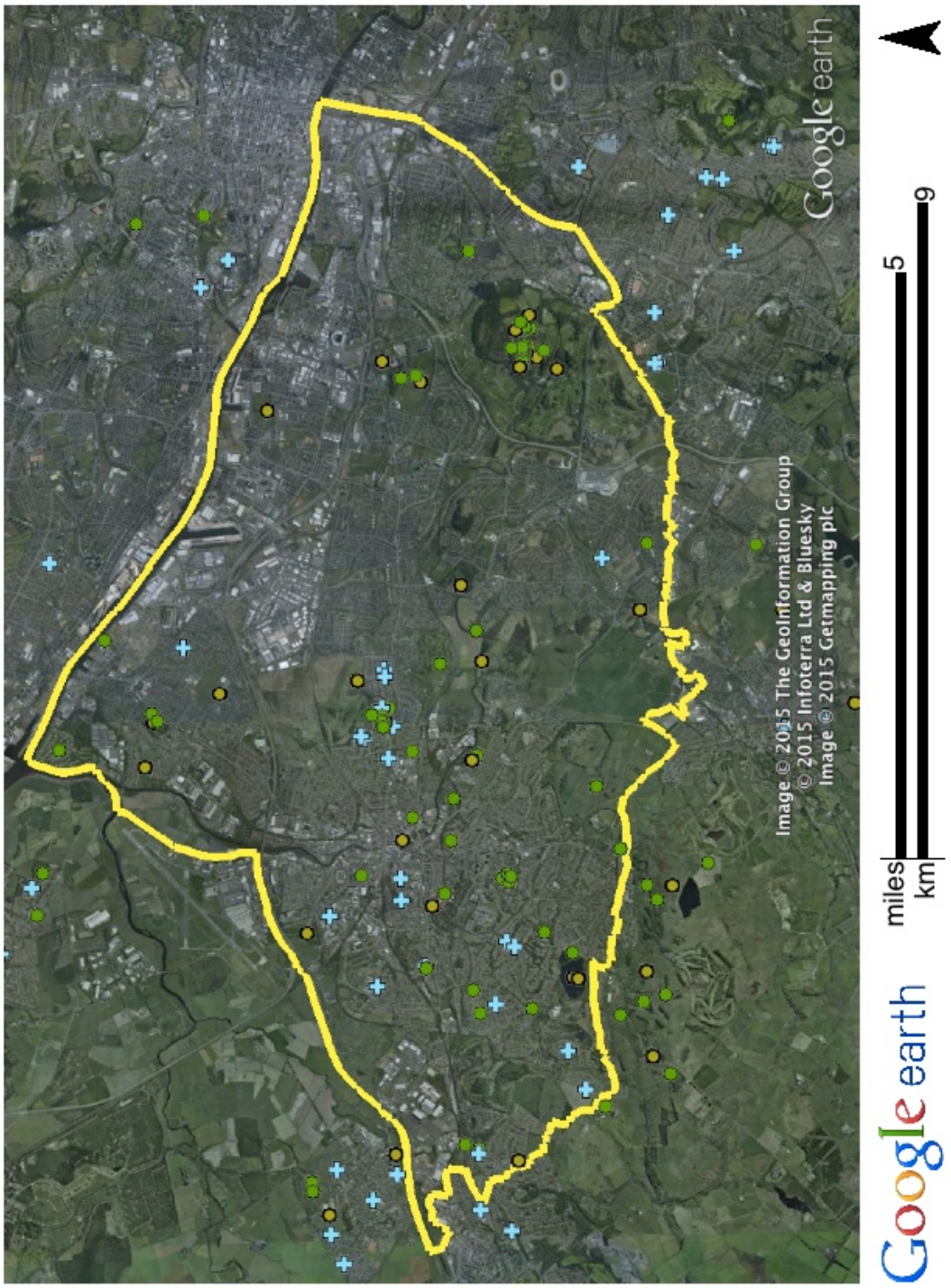


Figure 9.16
Home Locations (+) and GS Locations (O) – Paisley CA

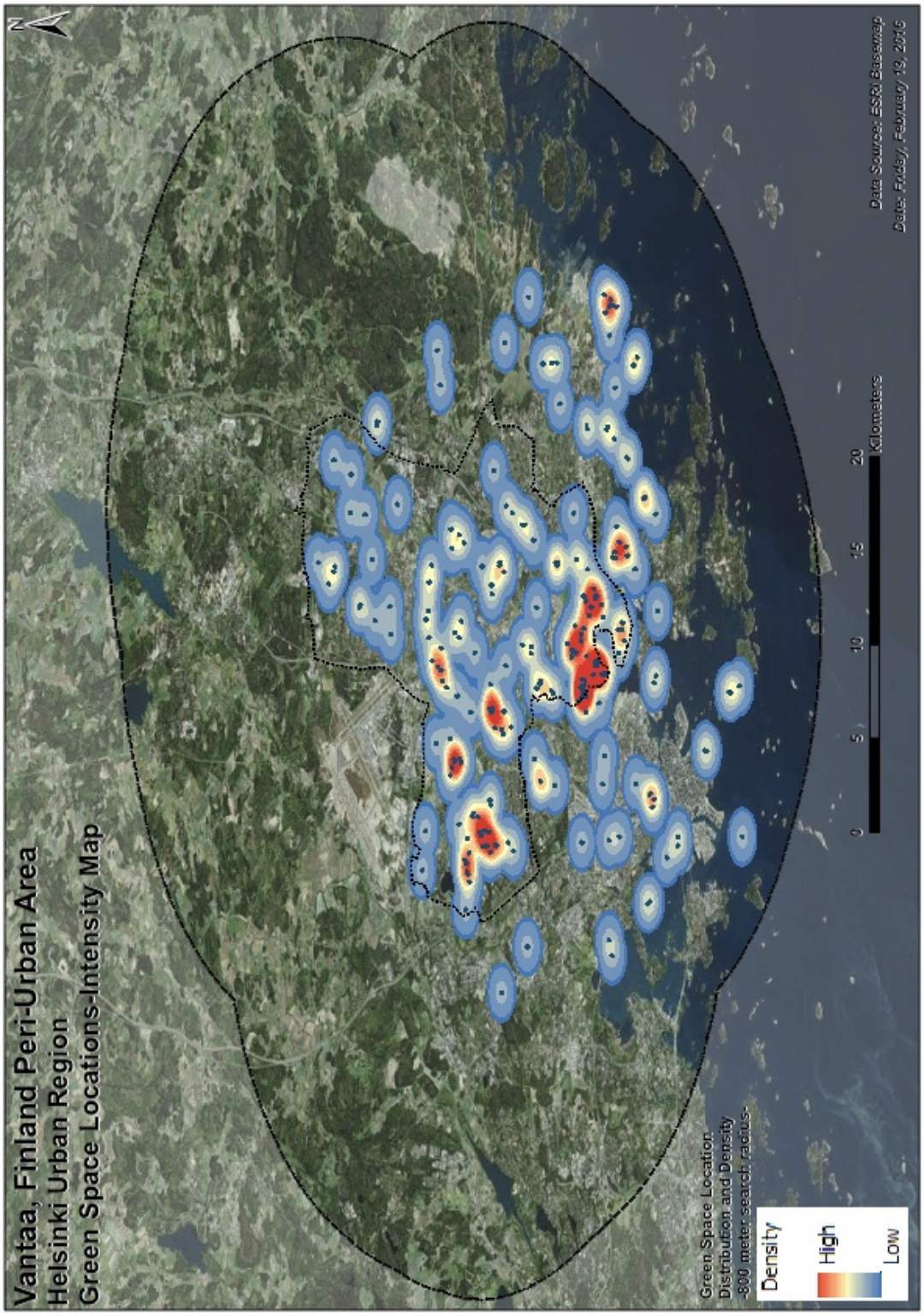


Figure 9.17
GS Locations Heat Map – Vantaa CA

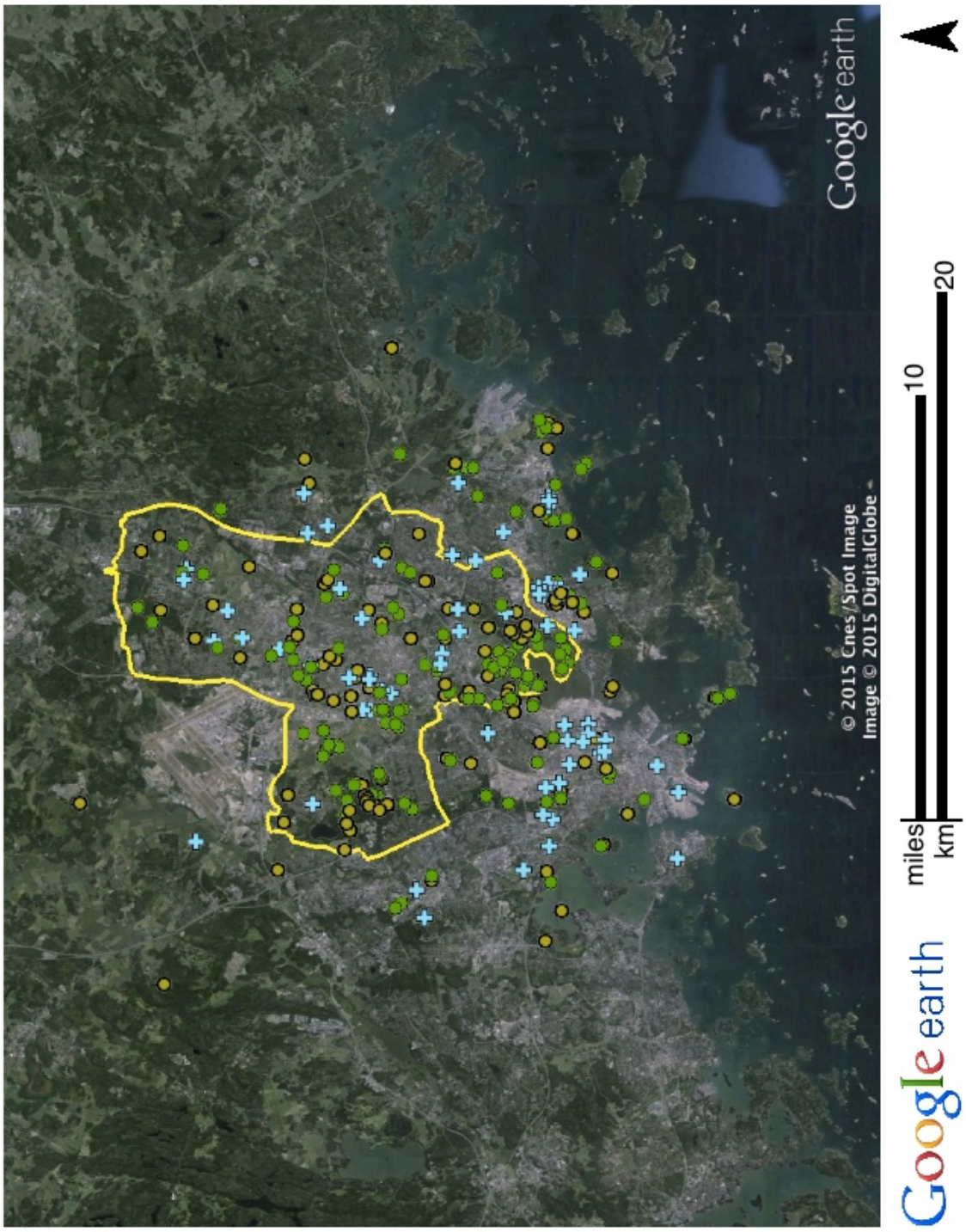


Figure 9.18
Home Locations (+) and GS Locations (O) – Vantaa CA

This section's descriptive analysis organizes its results and discussion through the following landscape factors:

Structural Landscape Factors
(within PPUIGS Characteristic Performance Index)

- Size;
- Shape;
- Edge;
- Greenness;
- Proximity.

Non-Structural Landscape Factors
Grouping 1 (within PPUIGS Characteristic Performance Index)

- Maintenance and Management;
- Safety and Security;
- Features and Facilities.

Grouping 2

- GS Ownership
- GS Titled or Named
- GS Typologial Definition
- GS Special Designation
- GS within Case Study Area SQ Boundary
- Mode of access to GS selected
- Distance to Nearest GS
- Was Nearest GS visited

Figure 9.19
Descriptive Analysis – Landscape Factors

This descriptive analysis presents the results tabulated from the SQ for the various socio-ecological characteristics and landscape factors of the PPUIGS as marked by the respondents organised through the structural and non-structural factors.

9.5.2.1 Descriptive Analysis Results – Structural Landscape Factors

This section reports the GS structural data within each CA as identified through the SQ and correlated to the PPUIGS Characteristic Performance Indexes Characteristics, Attributes and Levels within Figure 7.30. This section reports the structural data on the PPUIGS (i.e. combined FGS and OGS) within each CA. This section illustrates most simple statistics with full results shown in Appendix 19. *Note: Results indicate GS they visit, not prefer.*

In respect to each CA's GS selections (i.e. FGS and OGS) utilised in this analysis, the total range of different selections were determined *not* by all available GS in the catchment area nor the total GS markers provided by the respondents, but only those unique GS selections made by the respondents. For example, the total number of GS markers (n=182) for the Paisley CA was determined by the aggregate of all geomarker locations. However, for structural analysis, duplicate GS were not required as geomaker locations were shared between respondents. Thus, a total of 57 unique and specific GS were analysed (n=57); these 57 GS locations are not duplicated in analysis.

Additionally, although the SQ requested three FGS markers, some respondents provided four FGS markers; in these cases all four were added to the dataset. Also, the SQ requested 'as many green spaces as you wish' for their OGS markers. Some respondents provided up to four OGS markers and all these were added to the dataset.

Paisley CA ≤ 182 individual GS locations (n=182) provided by respondents.
Vantaa CA ≤ 247 individual GS locations (n=247) provided by respondents.

Table 9.3
Effective Structural Landscape Factors GS Sample Sizes

Paisley CA
Size Characteristics
70% of respondents (n=122) selected an Extensive GS which separate houses and structures well so you do not see houses when in the GS.
69% of respondents (n=125) selected a High Density GS from which you can see another GS when in the GS.
53% of respondents (n=88) selected a Moderately Sized GS.

Shape Characteristics

38% of respondents (n=69) selected an Urban GS.

45% of respondents (n=78) selected a Regularly Shaped GS with mostly evenly-spaced and/or evenly-lengthed sides (rectangle, square, or mostly equilateral polygon) as a GS.

43% of respondents (n=74) selected a Simply Shaped GS which is uniform in shape (3-4 sides).

Proximity Characteristics

70% of respondents (n=128) selected a Connected GS which is considered one in a group of GS.

57% of respondents (n=102) selected a Grouped GS from which you can see another GS when in the GS.

47% of respondents (n=76) selected an Integrated GS which is physically part of another GS.

Edge Characteristics

39% of respondents (n=61) selected a Numerously Edged GS with 8 or more edges.

68% of respondents (n=109) selected a Moderately Lengthed Edged GS when compared to other GS within the CA.

39% of respondents (n=69) selected a Moderately Dense Edge GS where some edge areas offer visibility into the GS.

Level of Greenness Characteristics

51% of respondents (n=92) selected a primarily Deciduously Vegetated GS.

46% of respondents (n=83) selected a Semi-Natural GS.

51% of respondents (n=92) selected a Uniform Distribution of Horizontally Vegetated GS.

48% of respondents (n=86) selected a Clustered Distribution of Vertically Vegetated GS.

42% of respondents (n=75) selected a Openly Vegetated GS.

48% of respondents (n=88) selected a GS located Close or directly adjacent to a heavy trafficked road.

51% of respondents (n=93) selected a GS with a many (3+) of Extensive and long views when located within the GS.

Figure 9.20
Paisley CA Structural Landscape Factors Summary
Highest Frequency Attributes

Vantaa CA

Size Characteristics

62% of respondents (n=152) selected an Extensive GS which separate houses and structures well so you do not see houses when in the GS.

46% of respondents (n=103) selected a Moderate Density GS from which you can see another GS when in the GS.

36% of respondents (n=95) selected a Moderately Sized GS.

Shape Characteristics

61% of respondents (n=149) selected a Natural GS.

41% of respondents (n=101) selected an Irregularly Shaped GS with mostly evenly-spaced and/or evenly-lengthed sides (rectangle, square, or mostly equilateral polygon) as a GS.

36% of respondents (n=88) selected a Moderately Complex Shaped GS which is neither complex nor simple in shape (4-8 sides).

Proximity Characteristics

81% of respondents (n=200) selected a Connected GS which is considered one in a group of GS. (Separated = 5% , n=13)

77% of respondents (n=189) selected a Grouped GS from which you can see another GS when in the GS. (Isolated = 7%, n=17)

77% of respondents (n=190) selected an Integrated GS which is physically part of another GS.

Edge Characteristics

39% of respondents (n=95) selected a Numerously Edged GS with 8 or more edges.

39% of respondents (n=97) selected a Moderately Lengthed Edged GS when compared to other GS within the CA.

41% of respondents (n=100) selected a Densely Edge GS where edge areas block visibility into the GS.

Level of Greenness Characteristics

86% of respondents (n=209) selected a Mixed Vegetated GS.

47% of respondents (n=115) selected a Natural GS.

50% of respondents (n=122) selected a Uniform Distribution of Horizontally Vegetated GS.

51% of respondents (n=123) selected a Diverse and Random Distribution of Vertically Vegetated GS.

43% of respondents (n=92) selected a Densely Vegetated GS.

45% of respondents (n=110) selected a GS located Close or directly adjacent to a heavy trafficked road.

43% of respondents (n=105) selected a GS with a many Limited amount or zero (0)Extensive and long views when located within the GS.

Figure 9.21
Vantaa CA Structural Landscape Factors Summary
Highest Frequency Attributes

Comparison of Combined PPUIGS Characteristics between CAs

This comparison describes what types of PPUIGS respondents visit and interact with (not necessarily for their HWB benefits; just a broad picture of the structural characteristics which change among the PPUIGS they selected). The following structural differences between CAs were reported:

Only one of the three size characteristics changed between CAs

Size – Density		
Paisley CA	Extensive	69%, n=125
Vantaa CA	Moderate	46%, n=103

Figure 9.22
Size Characteristics GS Highest Frequency Comparisons

All three shape characteristics changed between CAs:

Shape – Regulation - Greenness			
Paisley CA	Urban	39%, n=69	
Vantaa CA	Natural	61%, n=141	
Shape – Regulation -			
Paisley CA	Regular	45%, n=78 (regularly shaped, even sides)	
Vantaa CA	Irregular	41%, n=101 (irregular shaped, uneven sides)	
Shape – Complexity			
Paisley CA	Simple	43%, n=74	(simple & uniform shaped, 3-4 sides)
Vantaa CA	Moderate	36%, n=88	(somewhat complex and diverse shaped, 4-8 sides)

Figure 9.23
Shape Characteristics GS Frequency Comparisons

None (0) of the three proximity characteristics selected changed between CAs (i.e. respondents from both selected connected, grouped and integrated PPUIGS).

One of the three edge characteristics selected changed between CAs:

Edge – Density	
Paisley CA	Moderately Dense
Vantaa CA	Dense

Figure 9.24
Edge Characteristics GS Highest Frequency Comparisons

Five of the seven levels of greenness characteristics selected changed between CAs:

Greenness – Vegetation Composition		
	Paisley CA	Deciduous
	Vantaa CA	Mixed
Greenness – Vegetation Setting		
	Paisley CA	Semi-Natural
	Vantaa CA	Natural
Greenness – Vertical Vegetation Structure		
	Paisley CA	Clustered
	Vantaa CA	Diverse and Random
Greenness –Vegetation Density		
	Paisley CA	Open
	Vantaa CA	Dense
Greenness – Visibility		
	Paisley CA	Extensive Visibility – Many Extensive Views
	Vantaa CA	Limited Visibility - Few Extensive Views

Figure 9.25
Greenness Characteristics GS Highest Frequency Comparisons

Overall, the Paisley CA respondents indicated with different size, shape, edge, and level of greenness characteristics than the Vantaa CA respondents, while the PPUIGS characteristic of proximity remained constant, indicating, generally, the aspect of connectivity was important for both samples.

9.5.2.2 Descriptive Analysis Results – Non-Structural Landscape Factors – Grouping 1

This section reports and summarises the non-structural data of the GS within each CA as organised through the PPUIGS Characteristic Performance Index (See). This section illustrates most of the GS simple statistics with full results for the FGS and OGS shown in Appendix 19. *Note: Results indicate GS they indicated they had visited, not preferred.*

Paisley CA ≤ 182 individual GS locations (n=182) provided by respondents.
Vantaa CA ≤ 247 individual GS locations (n=247) provided by respondents.

Table 9.4
Effective Non-Structural Landscape Factors GS Sample Sizes

Paisley CA

Maintenance and Management Characteristics

53% of respondents (n=96) selected a Clean and well maintained or managed GS.
43% of respondents (n=78) selected a GS with Abundant Facilities.
42% of respondents (n=76) selected a GS with primarily Paved Paths.
58% of respondents (n=104) selected a GS with Facilities that Promote High Sociability.

Safety and Security Characteristics

54% of respondents (n=99) selected a Somewhat Safe GS.

Vantaa CA

Maintenance and Management Characteristics

59% of respondents (n=145) selected a Moderately Clean and well maintained or managed GS.
46% of respondents (n=112) selected a GS with Adequate Facilities.
57% of respondents (n=40) selected a GS with primarily Unpaved Paths.
48% of respondents (n=118) selected a GS with Facilities that Promote Mixed Sociability.

Safety and Security Characteristics

56% of respondents (n=136) selected a Somewhat Safe GS.

Figure 9.25
Highest Frequency
PPUIGS Characteristics (Non-Structural Landscape Factors)

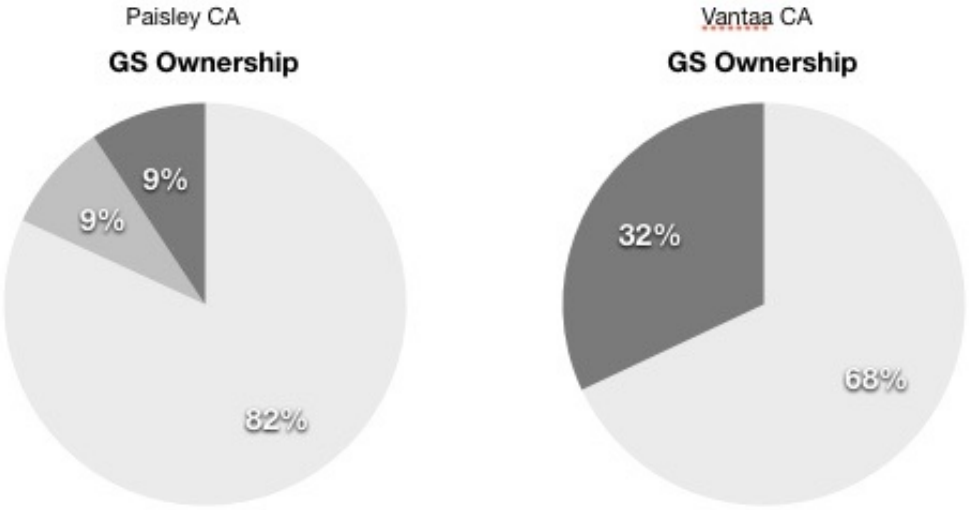
Both CA respondents predominately selected GS with somewhat safe levels of safety and security. However, all four of the maintenance and management characteristics selected by respondents changed levels between CAs:

M & M – Cleanliness		
	Paisley CA	Clean
	Vantaa CA	Moderately Clean
M & M – Facilities		
	Paisley CA	Abundant
	Vantaa CA	Adequate
M & M – Paths		
	Paisley CA	Mixed
	Vantaa CA	Unpaved
M & M – Sociability		
	Paisley CA	High
	Vantaa CA	Mixed

Figure 9.26
Highest Frequency Comparison
Non-Structural Landscape Factors

9.5.2.3 Descriptive Analysis Results – Non-Structural Landscape Factors – Grouping 2

This section reports and summarises the non-structural data of the GS within each CA. The methodologies and specific criteria and characteristics of each factor are located within Appendix 16. This section illustrates the GS simple statistics with full results for the FGS and OGS shown in Appendix 18.



	Public	Private	Unknown
Paisley, Scotland CA	149	16	17
Vantaa, Finland CA	168	0	79

Paisley CA
82% of GS markers (n=149) are in Public Ownership
9% of GS markers (n=16) are in Private Ownership
9% of GS markers (n=17) are in Unknown Ownership

Vantaa CA
68 % of FGS markers (n=168) are in Public Ownership
0% of FGS markers (n=0) are in Private Ownership
32% of FGS markers (n=79) are in Unknown Ownership

Figure 9.27: GS Ownership

Overall, most GS visited were publicly owned (82% and 68%) which refers to the management and maintenance responsibilities of public councils and/or government agencies and allowes for public access (vs. private/limited access).

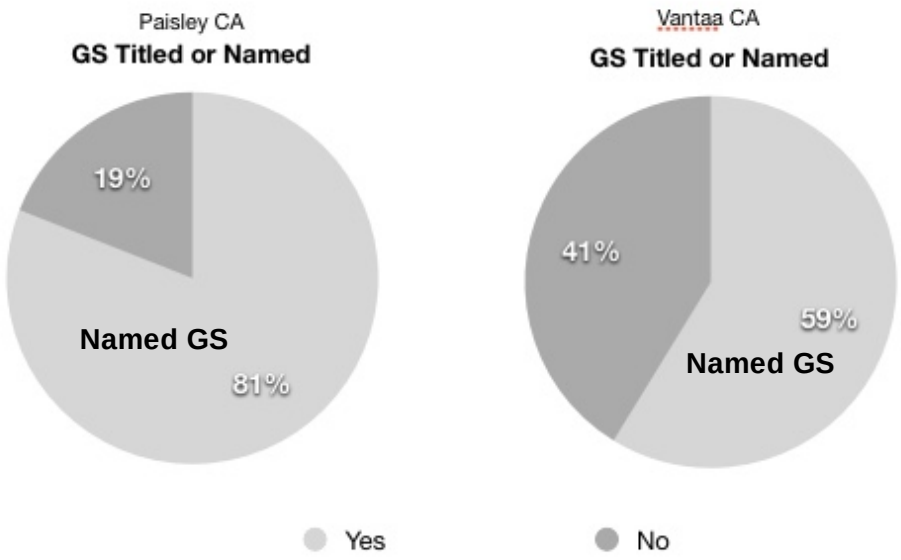


Figure 9.28: GS Titled or Named

The Paisley and Vantaa respondents indicated visitations to a named GS (81% and 41%, respectively). Named GS refers to the characteristic of whether the GS identified included a specific nomenclature or association to a name such as a Regional Park or City Park (e.g. Glasgow Regional Park, Hensinken Riverway, etc.). This result did not measure the number of overall ‘named’ GS within the CA. The higher percentage of ‘named’ GS potentially indicates a level of comfort, safety and familiarity when selecting a GS to visit. Although language translation and cultural familiarity with the GS were addressed, it is likely that this was insufficient, thus this result is considered unreliable. Though the SQ clearly and succinctly explained that respondents should report any type of GS they visited, whether formal or not, named/titled or not, and with examples provided to illustrate what a GS could be beyond a 'park’, respondents within the Paisley CA predominately listed 'named’ GS.

Overall, 81.3% (n=148) of the total 182 GS location markers provided were named GS within the Paisley CA. This potentially indicates a level of comfort,

safety and familiarity when selecting a GS to visit for Paisley CA respondents moreso than the Vantaa CA. However, translation and cultural familiarity with the GS were addressed but likely were lacking, thus this result is considered not reliable.

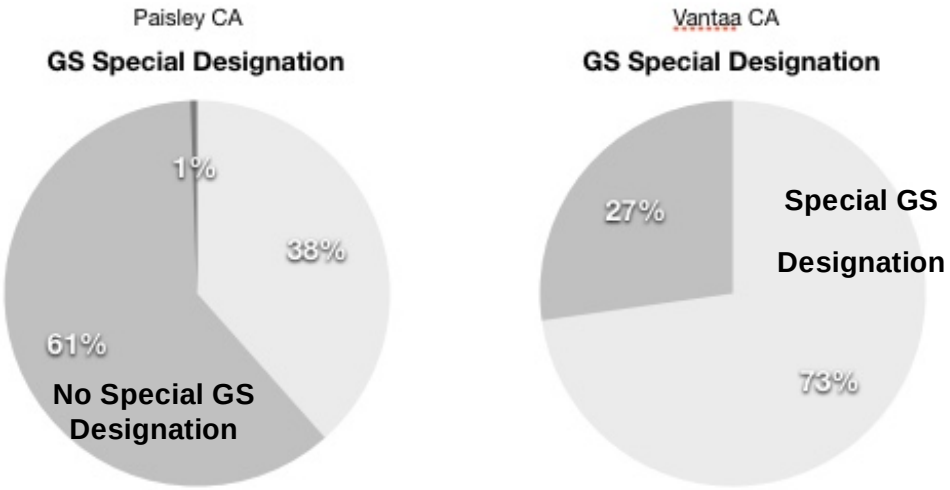
Paisley CA
54.9% of GS markers (n=100) are a Park Typology
9.3% of GS markers (n=17) are an Outdoor Sports Facility Typology
7.1% of GS markers (n=13) are an Other Natural or SemiNatural GS Typology
6.6% of GS markers (n=12) are a Water and Wetland Typology
6.0% of GS markers (n=11) are a Green Corridor Typology
4.4% of GS markers (n=8) are an Agricultural Typology
4.4% of GS markers (n=8) are a Woodland Typology
2.2% of GS markers (n=4) are a Grassland Typology
1.1% of GS markers (n=2) are an Amenity Green Space Typology
1.1% of GS markers (n=2) are a Garden and Grounds Typology
1.1% of GS markers (n=2) are an Other Green Space Typology
0.5% of GS markers (n=1) are a Civic Space Typology
0.5% of GS markers (n=1) are a Cemetery and Churchyard Typology
0.5% of GS markers (n=1) are a Children's Play Area Typology
0.0% of GS markers (n=0) are a Community Garden and Allotment Typology

Vantaa CA
37% of GS markers (n=92) are a Woodland Typology
13% of GS markers (n=31) are an Other Natural or Semi-Natural GS Typology
13% of GS markers (n=31) are a Park Typology
10% of GS markers (n=25) are a Green Corridor Typology
5% of GS markers (n=12) are an Amenity Green Space Typology
4.5% of GS markers (n=11) are a Water and Wetland Typology
4% of GS markers (n=10) are a Garden and Grounds Typology
3% of GS markers (n=8) are a Community Garden and Allotment Typology
2.5% of GS markers (n=6) are an Agricultural Typology
2% of GS markers (n=5) are an Other Green Space Typology
2% of GS markers (n=5) are an Outdoor Sports Facility Typology
1.5% of GS markers (n=4) are a Grassland Typology
1.5% of GS markers (n=4) are a Children's Play Area Typology
0.5% of GS markers (n=2) are a Cemetery and Churchyard Typology
0% of GS markers (n=0) are a Civic Space Typology

Figure 9.29: GS Typological Definition

Generally, respondents within each CA indicated certain types of GS they visit – here, predominately Park (55%) for the Paisley CA and Woodland (37%) typologies for Vantaa CA. This result does not tell us if there is a high frequency, overall, of each of those typologies of GS within the region, only those which

respondents indicated. Interestingly, the results show 0% for community gardens for respondents within the Paisley CA, perhaps indicative of the presence of home gardens, a common planning strategy within the UK's housing development.

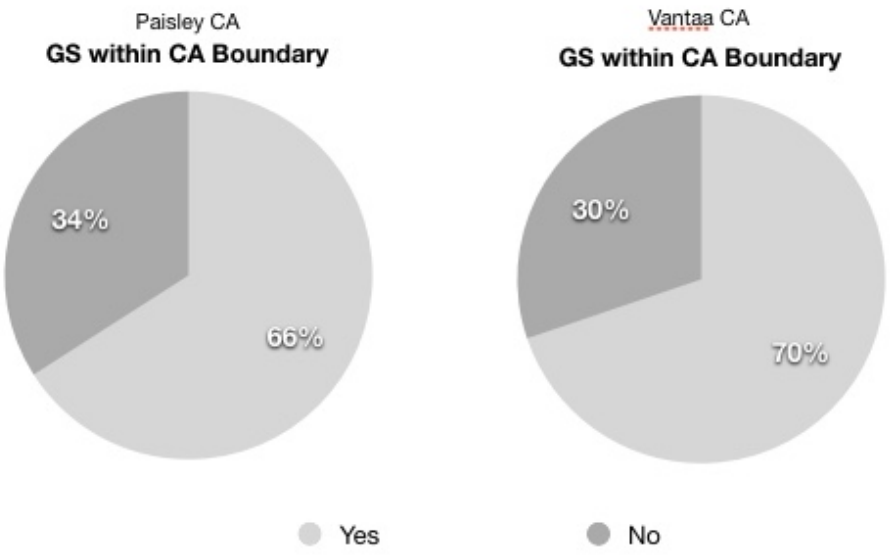


	Yes	No	Unknown
Paisley, Scotland CA	70	111	1
Vantaa, Finland CA	203	76	0

Paisley CA
38.5% of GS markers (n=70) have a Special Designation
61.0% of GS markers (n=111) do not have a Special Designation
0.5% of GS markers (n=1) are an Unknown Special Designation

Vantaa CA
87% of GS markers (n=203) have a Special Designation
13% of GS markers (n=76) do not have a Special Designation
0% of GS markers (n=0) are an Unknown Special Designation

Figure 9.30: GS Special Designation

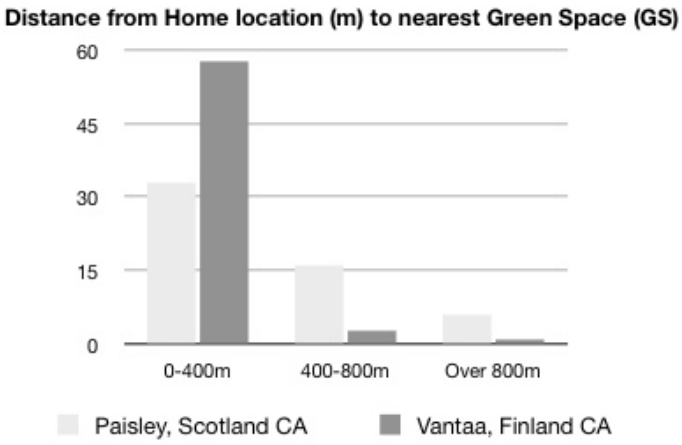


	Yes	No
Paisley, Scotland CA	120	62
Vantaa, Finland CA	171	74

Paisley CA
66% of GS markers (n=120) are within CA
34% of GS markers (n=62) are not within CA

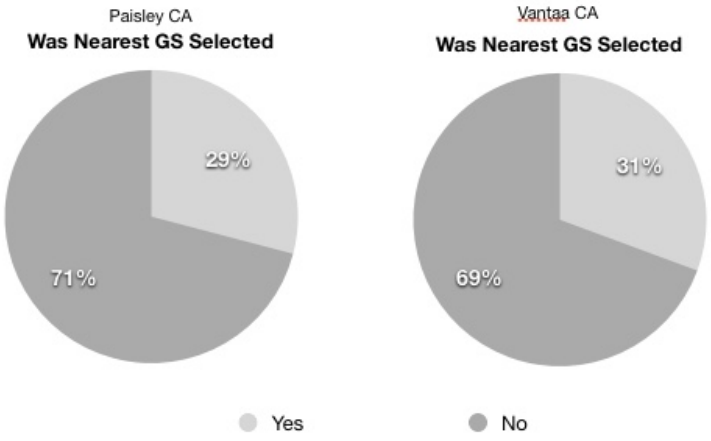
Vantaa CA
70% of GS markers (n=171) are within CA
30% of GS markers (n=74) are not within CA

Figure 9.31: GS within CA Boundary



	0-400m	400-800m	Over 800m
Paisley, Scotland CA	33	16	6
Vantaa, Finland CA	58	3	1

Figure 9.32: Distance from Home Location (m) to nearest GS

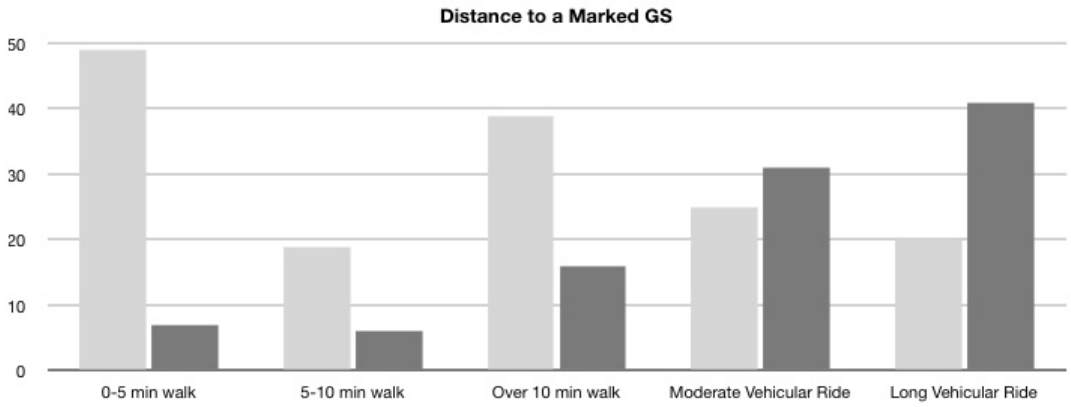


	Yes	No
Paisley, Scotland CA	16	39
Vantaa, Finland CA	19	43

Figure 9.33: Was Nearest GS Selected

In this research, only 29% of Paisley respondents indicated their nearest GS as opposed to 31% for Vantaa. Within the Paisley CA, 57% of respondents' home locations were within a 400m distance, or 5 minute walk, to an identified GS, the Nearest GS. In the Vantaa CA, this increased to 94%. Although these measures do not indicate actual interaction or frequency of use, it does begin to provide a sense of the spatial quality to the CA's distribution of GS, suggesting, even though rather weakly, that there are more GS located closer to homes within Vantaa than Paisley. There are many reasons why this is an unsupported conclusion, such as whether Vantaa housing developments were purposefully planned with GS nearby and protected from human development, or whether the sample in Vantaa was biased towards those with GS nearby in terms of who finished the SQ.

The reasons for not visiting the nearest GS are largely unaccounted for in this research's context, such as physical barriers (i.e. locked gates) and other obstructions to visitation such as lack of transportation or explicit safety concerns (e.g. unsafe road crossings), broken lighting, neighbourhood culture/separation, lack of direct/clear access (e.g. pathways) and other factors not recognised within this research's eco-spatial framework. Potential explanations for these results are varied and include the individualistic importance and value to distant GS not found in local GS, or the quality of nearby GS. Lastly, GS near to homes and residential developments may be considered more noisy, with only the distant GS providing a sense of peace and quiet.



	0-5 min walk (0-400m)	5-10 min walk (400-800m)	over 10 min walk (Over 800m)	Moderate Vehicular Ride (1-2km)	Long Vehicular Ride (Over 2km)
Paisley, Scotland CA	49	19	39	25	20
Vantaa, Finland CA	7	6	16	31	41

Paisley CA
26.9% of respondents (n=49) listed a GS with a 0-5 minute walk
10.4% of respondents (n=19) listed a GS with a 5 -10 minute walk
21.4% of respondents (n=39) listed a GS with over a 10 minute walk
13.7% of respondents (n=25) listed a GS with Mod vehicular ride
27.5% of respondents (n=50) listed a GS with Long vehicular ride

Vantaa CA
6.9% of respondents (n=7) had a GS with a 0-5 minute walk listed as GS.
5.9% of respondents (n=6) had a GS with a 5 -10 minute walk listed as GS.
15.8% of respondents (n=16) had a GS with over a 10 minute walk listed as GS.
30.7% of respondents (n=31) had had a GS with Mod vehicular ride listed as GS.
40.6% of respondents (n=41) had a GS with Long vehicular ride listed as GS.

Figure 9.34: Distance to a Marked GS

According to the literature, distance to GS is the most important factor related to its use. The closer a GS is to each individual home, the more it is used (Coles and Bussey, 2000; Giles-Corti et al., 2005a; Grahn and Stigsdotter, 2003; Jensen and Koch, 2004; Nielsen and Hansen, 2006; Roovers et al., 2002). A distance of 300-400 metres is often mentioned as a threshold after which use starts to decline (Coles and Bussey, 2000; Giles-Corti et al., 2005; Grahn and Stigsdotter, 2003; Nielsen and Hansen, 2006). Respondents in both CAs distinctly visited GS beyond a 2km distance or long vehicular ride (28% Paisley CA, 44% Vantaa CA),

but 27% of respondents within the Paisley CA also visited GS within 400 m or a 5 minute walk, whereas in the Vantaa CA, only 9% of respondents visited a GS within a similar proximity. It is hard to draw clear conclusions from these results, since although they show that similar percentages of Paisley CA respondents visit very close and very far GS, those in the Vantaa CA seem not to visit close GS, but rather 69% visit GS more than 2km away. These results do seem to indicate that travel distance and proximity is not a factor in visiting. The results of those GS visited within their specified CAs were not as distinct, however: only 67% of GS visited were within the Paisley CA and only 70% of GS were within the Vantaa CA.

In both datasets, having a GS nearby does not indicate use. This echoes research in a survey of the use of GS in Odense, Denmark, which showed that for 46% of the respondents the GS people used most was often not the one closest to them. A study by Wright Wendel et al. (2012) reported that individuals were willing to travel longer distances and times to urban parks because these spaces not only provided them perceived benefits, but also with *"new spaces that offer distractions"*. Although this research did not measure preference, these results do not support the findings of Burgess et al. (1988), who reported that people preferred local, familiar GS more than larger, more distant parks and landscapes.

Paisley CA – Highest 6 Named GS Geomarkers Frequencies
10% of respondents (n=18) listed Pollock Park as GS.
9% of respondents (n=16) listed Barshaw Park as GS.
6% of respondents (n=10) listed Glennifer Braes County Park – Robertson Park and Brodie Park as GS.
5.5% of respondents (n=10) listed Glennifer Braes County Park - Robertson Park as GS.
4.9% of respondents (n=9) listed Bellahouston Park as GS.
1.0% of respondents (n=5) listed Clyde Murishiel Regional Park - Castle Semple Loch as GS.

Vantaa CA – Highest 6 Named GS Geomarkers Frequencies
15% of respondents (n=38) listed Lamasaari Island as GS.
10% of respondents (n=25) listed Paloheina Woodlands as GS.
5% of respondents (n=12) listed Fastholma Green Space as GS.
3% of respondents (n=6) listed Kivinnoka Green Space as GS.
3% of respondents (n=6) listed Uutela Recreation Area as GS.
3% of respondents (n=6) listed Vantaa River near Silvola as GS.

Figure 9.35: Highest GS Geomarker Frequencies

The most visited GS within the Paisley CA was Pollock Park (10% of total responses) and Lamasaari Island within the Vantaa CA (15% of total responses), both located within their respective CA boundary (not 10km). The following non-structural factors were noted for the most frequent GS identified:

Paisley CA
100% of these 6 GS are Titled GS.
100% are public GS
50% have a Special Designation to them
83.3% are Park Typologies (1 Water)
66.6% are within the Catchment Area.

Vantaa CA
33.3% of these 6 GS are Titled GS.
66.6% are unknown ownership, 33.4% are public GS
87.5% have a Special Designation to them
66.6% are Woodland Typologies
87.5% are within the Catchment Area.

Table 9.5
Highest 6 Named GS Geomarker Frequency Summary

9.5.3 Descriptive Analysis Results – HWB Interaction Factors

This section reports and summarises the results tabulated from the SQ for the various Human Well-Being Benefits or Affordances of the geomarked GS by the respondents. As presented, during the SQ, participants were asked to indicate which activity they partook in during their visit; these prescribed activities were then coded to specific HWB benefits – physical, social or psychological. The Figures within this section each graphically represent the distribution of the HWB within the GS geomarkers, combining the PPUIGS eco-characteristics specific to HWB affordances.

The SQ's OGS marker placement in the survey allowed for multiple affordances to the same GS marker, the statistics for this were a little different, meaning the same GS could have multiple affordances assigned to it, similar to the way GS function in the real world. For example, although there were 182 individual GS locations (n=182) in the Paisley CA, there were a total of 227 unique individual GS affordance locations (n=227) provided by respondents. The total number of HWB markers analysed for each CA are noted below.

Paisley CA
Combined FGS and OGS (GS) Affordance
(physical, social, psychological)
182 individual GS locations (n=182) provided by respondents.
227 individual GS affordances (n=227) provided by respondents.

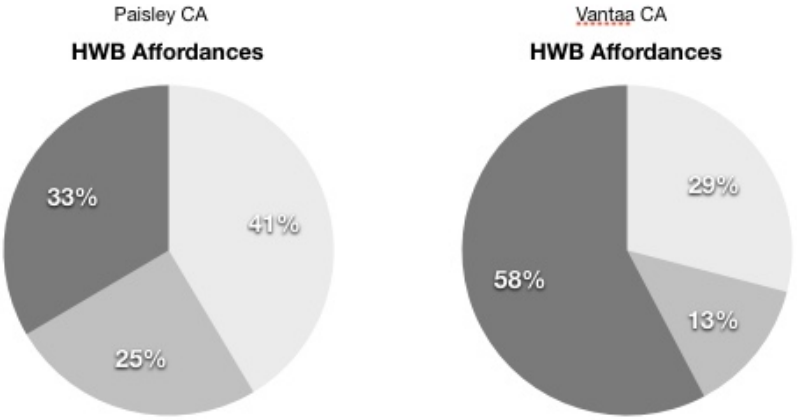
41 % (n=94) visited GS for psychological affordances
25 % (n=57) visited GS for social affordances
34% (n=76) visited GS for physical affordances

Vantaa CA
Combined FGS and OGS (GS) Affordance
(physical, social, psychological)
247 individual GS locations (n=247) provided by respondents.
265 individual GS affordances (n=265) provided by respondents.

29% (n=77) visited GS for psychological affordances
13% (n=35) visited GS for social affordances
58% (n=153) visited GS for physical affordances

Figure 9.36
Effective HWB Interaction Factors Sample Sizes

And Comparison HWB Interaction Factors

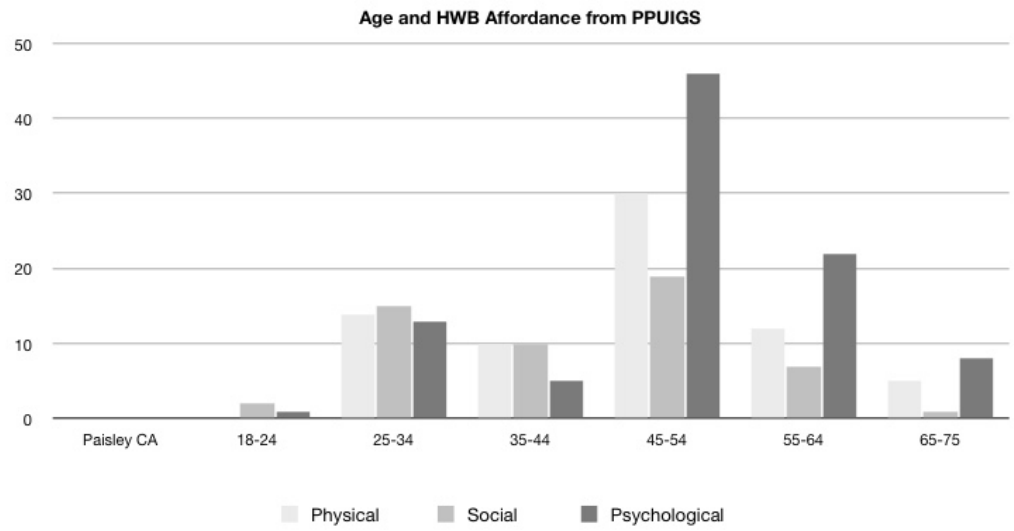


	Psychological	Social	Physical
Paisley, Scotland CA	94	57	76
Vantaa, Finland CA	77	35	153

Figure 9.37: Comparison HWB Interaction Factors

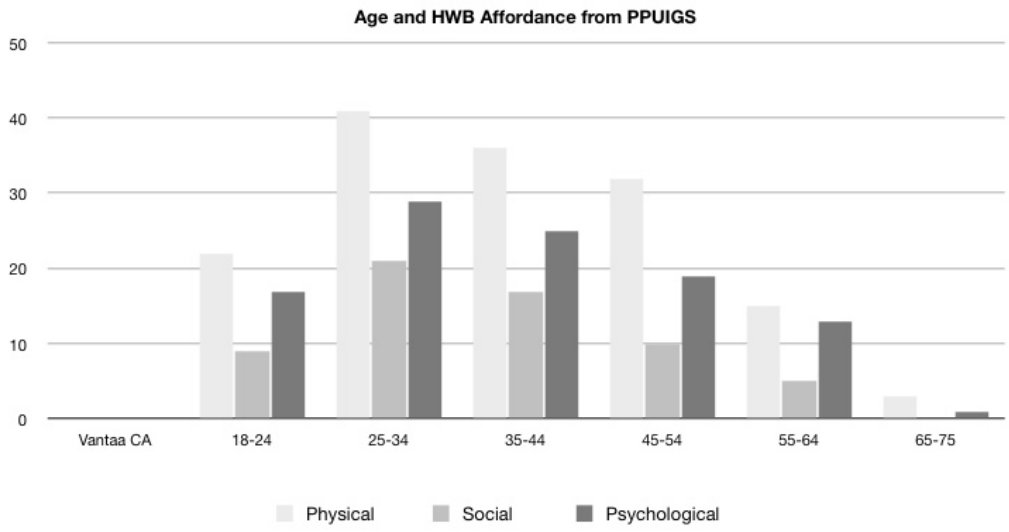
Overall, most respondents visited GS for psychological-based HWB benefits (41%) followed closely by physical-based affordances (33%) within the Paisley CA whereas within the Vantaa CA, respondents primarily visited GS for physical-based affordances (58%).

Age and HWB Affordance



Paisley CA	Physical HWB	Social HWB	Psychological HWB
18-24	0	2	1
25-34	14	15	13
35-44	10	10	5
45-54	30	19	46
55-64	12	7	22
65-75	5	1	8

Figure 9.38
Age and HWB Affordance from PPUIGS
Paisley CA

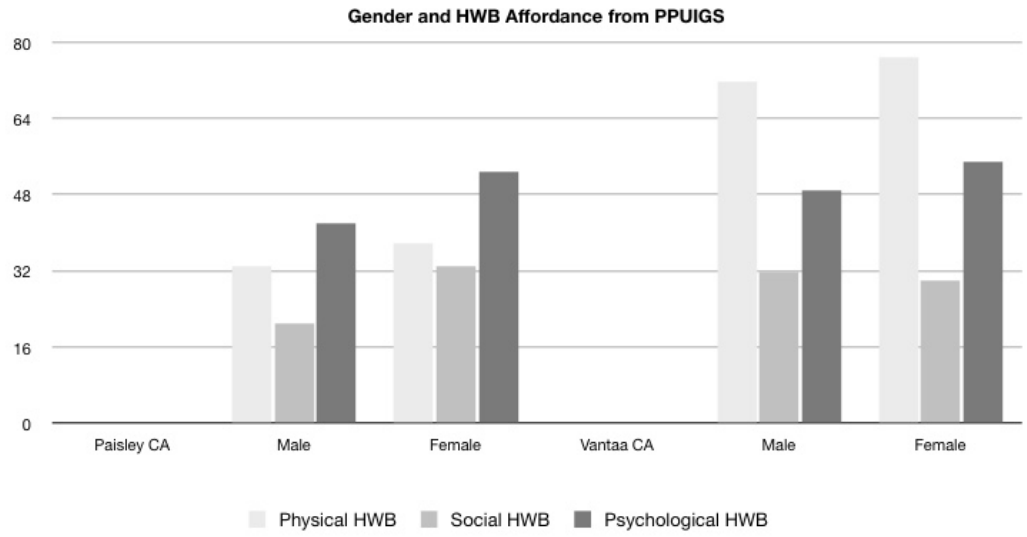


Vantaa CA	Physical HWB	Social HWB	Psychological HWB
18-24	22	9	17
25-34	41	21	29
35-44	36	17	25
45-54	32	10	19
55-64	15	5	13
65-75	3	0	1

Figure 9.39
Age and HWB Affordance from PPUIGS
Vantaa CA

Comparatively, based on the highest frequency results within the descriptive statistics, Paisley respondents, aged 45-55 (highest frequency age group) visited PPUIGS for psychological affordances whereas Vantaa respondents aged 25-34 (highest frequency age group) visited PPUIGS for physical affordances.

Gender and HWB Affordance

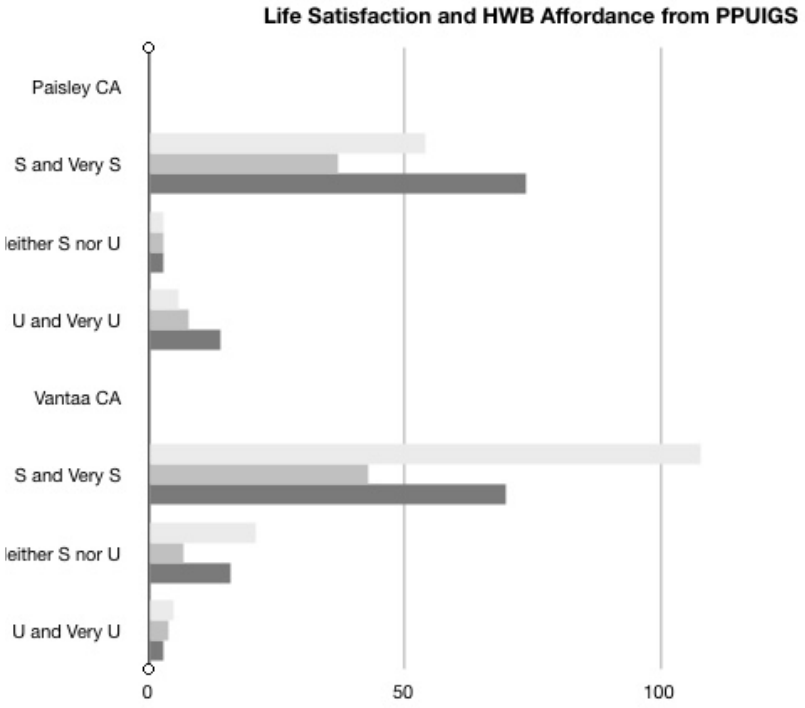


Paisley CA	Physical HWB	Social HWB	Psychological HWB
Male	33	21	42
Female	38	33	53
Vantaa CA	Physical HWB	Social HWB	Psychological HWB
Male	72	32	49
Female	77	30	55

Figure 9.40
Gender and HWB Affordance from PPUIGS
CA Comparison

Comparatively, based on highest frequency results within the descriptive statistics, for the Paisley CA, 44% males and 43% females visited GS primarily for a psychological HWB benefit. In the Vantaa CA, males and females visited GS primarily for a physical HWB benefit (52% and 45% respectively).

Life Satisfaction and HWB Affordance



Paisley CA	Physical HWB	Social HWB	Psychological HWB
S and Very S	54	37	74
Neither S nor U	3	3	3
U and Very U	6	8	14
Vantaa CA	Physical HWB	Social HWB	Psychological HWB
S and Very S	108	43	70
Neither S nor U	21	7	16
U and Very U	5	4	3

Figure 9.41
Life Satisfaction and HWB Affordance from PPUIGS

Comparatively, based on frequency for Paisley CA respondents, 45% of very satisfied and satisfied and 50% of very unsatisfied and unsatisfied visited GS most often for psychological HWB benefits. In the Vantaa CA, 49% very satisfied and satisfied 42% and of very unsatisfied and unsatisfied visited GS most often for physical HWB benefits.

Accessibility and HWB Affordance

In the Paisley CA, 53% of households owning a car visited a PPUIGS for a psychological HWB benefit, while in the Vantaa CA, 51% visited for Physical HWB benefits. This result does not indicate if they drove there in order to receive a HWB benefit, only the status of car ownership, and therefore these results are not useful in the context of this research. Further analysis, however, illustrates that those households owning a car who indicated they visited a PPUIGS through the use of a car mostly visited a GS for psychological HWB benefits in the Paisley CA, and a physical HWB benefit (51%) in the Vantaa CA. In both datasets, car ownership did not exclude the visitation of their nearest GS, potentially indicating GS accessibility is more important to the respondents in Paisley than those in Vantaa. Additionally, utilising bicycle transportation to visit a PPUIGS was significantly lower in the Paisley CA than Vantaa, raising questions as to whether there is a safe and ample bicycle infrastructure within the Paisley PUR and whether it is already part of current lifestyles.

HWB Interaction Factors Summary

The respondents in this research had distinct patterns of PPUIGS interaction. These results illustrate that respondents within each CA, generally, based on frequency of interaction, utilise their PPUIGS for different HWB benefits – psychological (41%) in the Paisley CA and physical (54%) within the Vantaa CA.

Overall, within the Paisley CA, 58% of respondents of all genders and ages predominately visited Parks and Gardens and Amenity GS typologies, whereas in the Vantaa CA, 41% of all genders and ages predominately visited Woodlands, Grasslands and Agricultural GS.

Paisley CA respondents aged 45-55 mostly visited Parks and Gardens and Amenity GS typologies for their psychological HWB benefit (47%) but it was the 35-44 age group of Vantaa CA respondents who mostly visited Woodlands, Grasslands and Agricultural GS typologies for their physical HWB benefit (66%).

Astell-Burt, Mitchell and Hartig (2014) found that availability of greenspace was associated with better mental health among men but not women;

this research somewhat supports such findings. Males in the Paisley CA primarily visited GS within a 400 m distance for psychological HWB benefits whereas it was for social HWB benefits for the Vantaa CA respondents.

Prior research has shown that dog ownership increases GS visitation frequency (Thompson et al., 2005). Although the suggestion from this research is that dog ownership does not influence GS use, dog ownership is very low in both CAs studied here, making generalisation difficult. Within both CAs, however, dog owners primarily visited GS with their dog for psychological HWB benefits (46% Paisley CA, 75% Vantaa CA). In Paisley, those who own dogs are more likely to visit their nearest GS than Vantaa. This is not a strong conclusion as there may be other sorts of spaces within Vantaa in which dogs are taken outside, such as plazas or unmarked/unrecorded GS.

9.5.3.1 Geospatial Mapping of HWB and PPUIGS Interaction

The following figures present the frequency distribution of HWB Affordance geomarkers as tabulated from the SQ (See Section 9.2.1). As discussed in Section 9.5.3, the gromarkers represent human interaction factors (i.e. affordances through behaviour) as expressed through the SQ's respondents and coded to specific psychological, social and physical based human wellbeing benefits (See Section 7.4.6.2). These results here simply summarise the FGS and OGS geomarkers – the GS. A full description and summary of the FGS and OGS HWB interaction Factors is located within Appendix 18 as they are mostly repetitive and only served as a means to gather information within the SQ through varied questions so as to maintain participant interest and graphic interaction. This section's heat maps (See Section 9.5.2) help visualise GS interaction patterns within the CA for specific HWB benefits. For the following maps, each geomarker as represented by the coloured diamond symbol represents a specific HWB affordance or group of HWB affordance (See Map Key). Each map, thus, illustrates the geographical location within each CA of specific HWB affordances provided though GS interaction. These maps serve as an general illustration to then analyse specific GS and GS eco-spatial characteristics at a smaller scale.

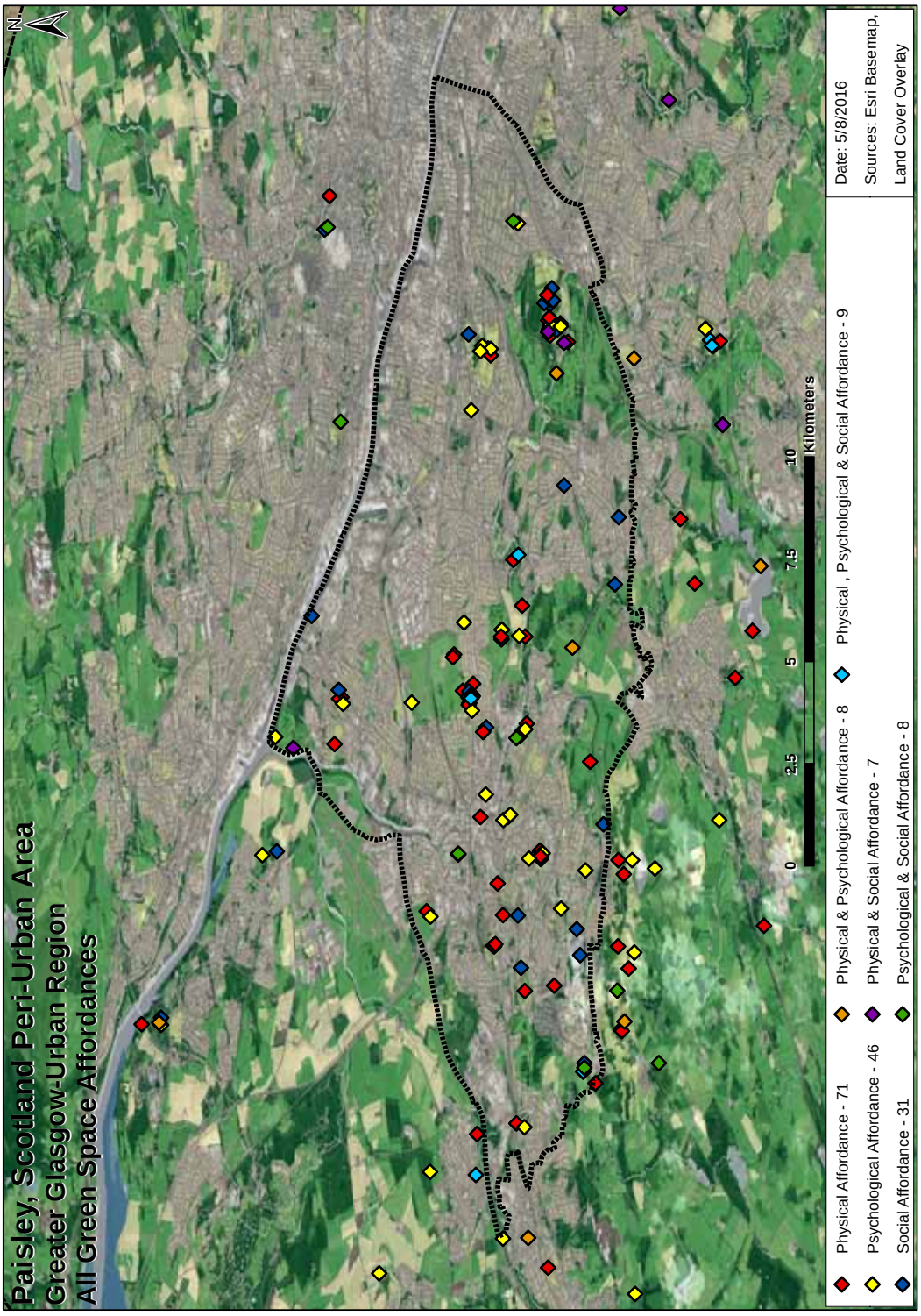


Figure 9.42
HWB Affordance Locations– Paisley CA
Each geomarker as represented by the coloured diamond symbol represents a specific HWB affordance or group of HWB affordances.

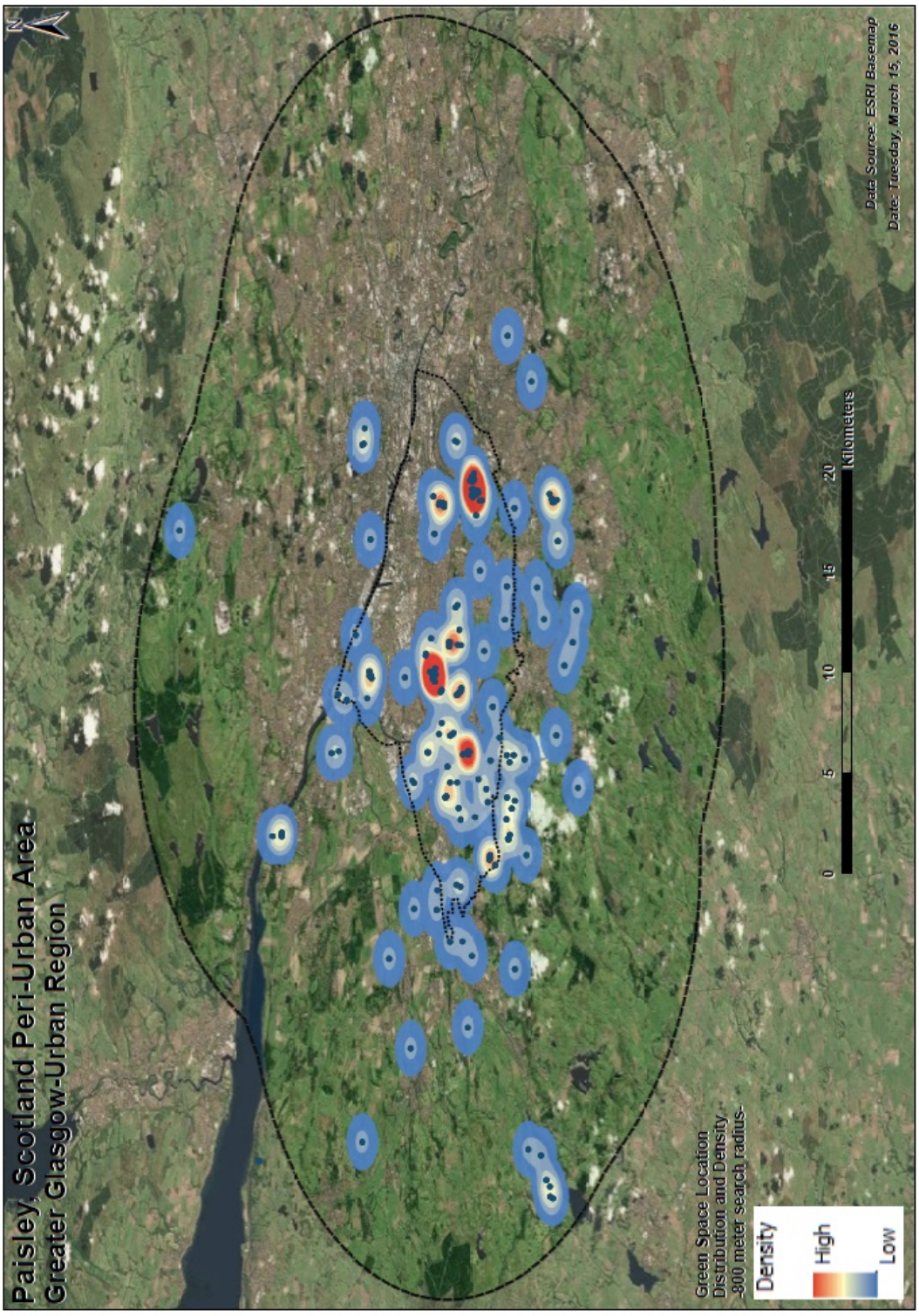


Figure 9.43
HWB Affordance Locations Heat Map – Paisley CA

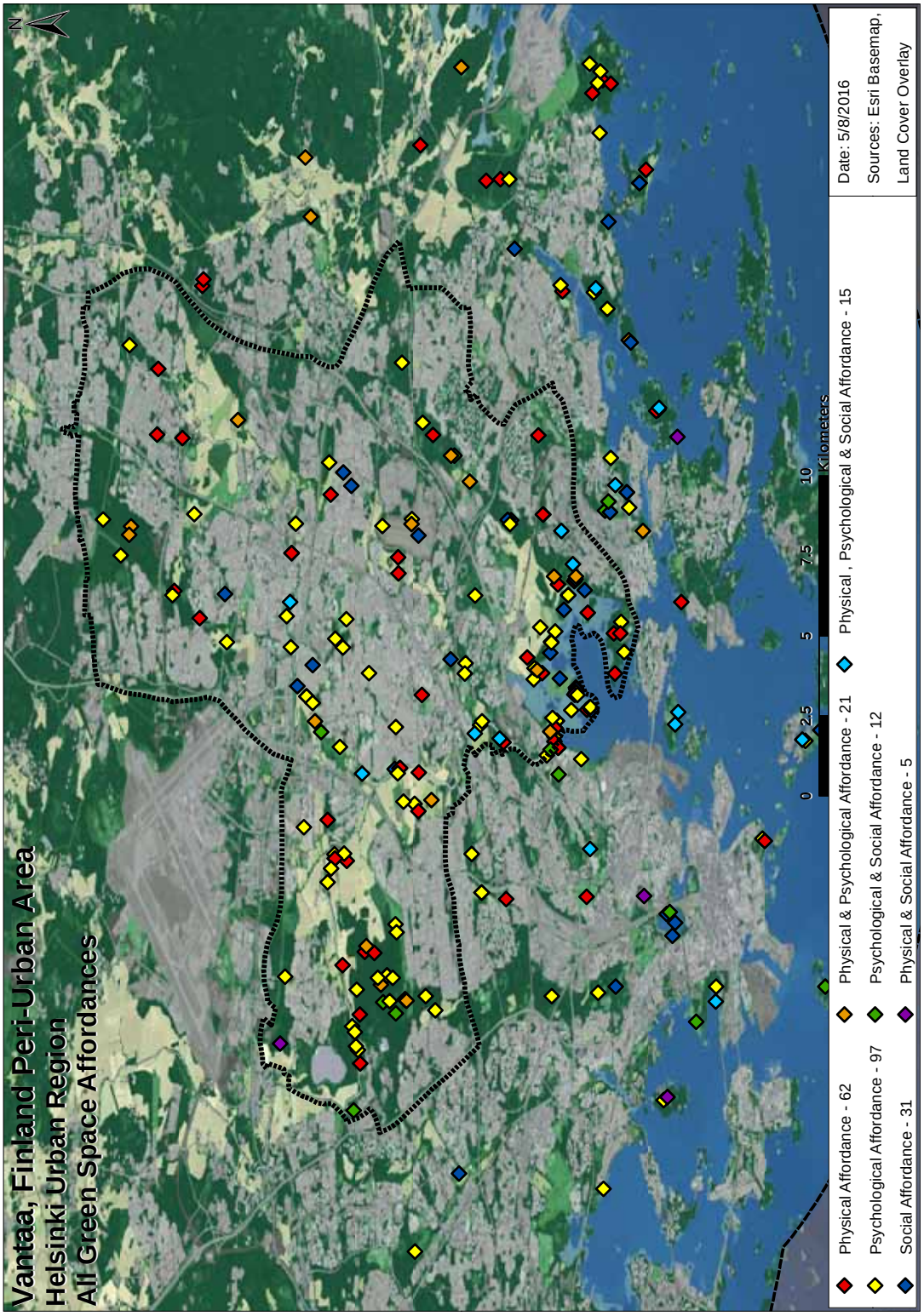


Figure 9.44
HWB Affordance Locations– Vantaa CA
Each geomarker as represented by the coloured diamond symbol represents a specific HWB affordance or group of HWB affordances.

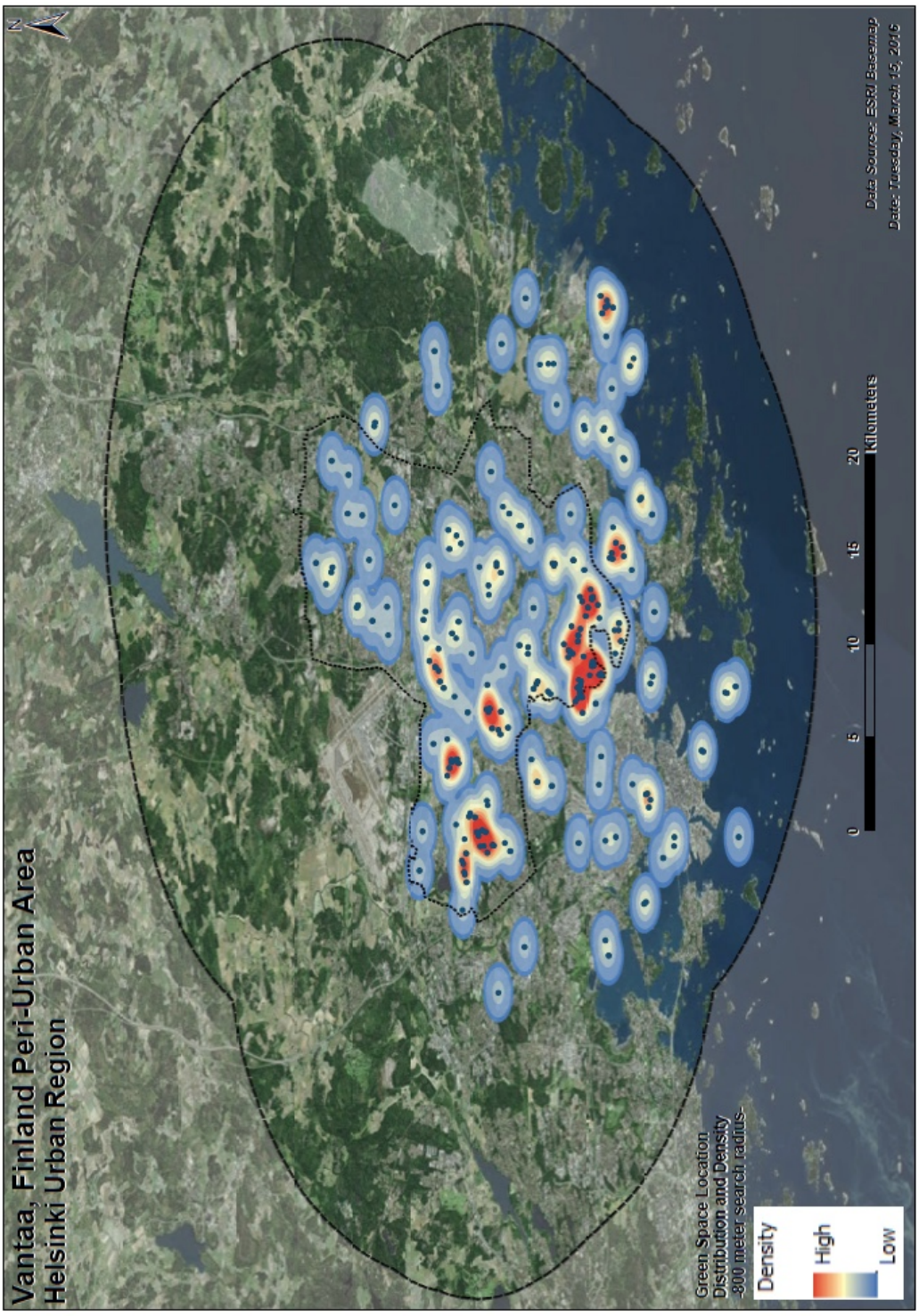


Figure 9.45
HWB Affordance Locations Heat Map – Vantaa CA

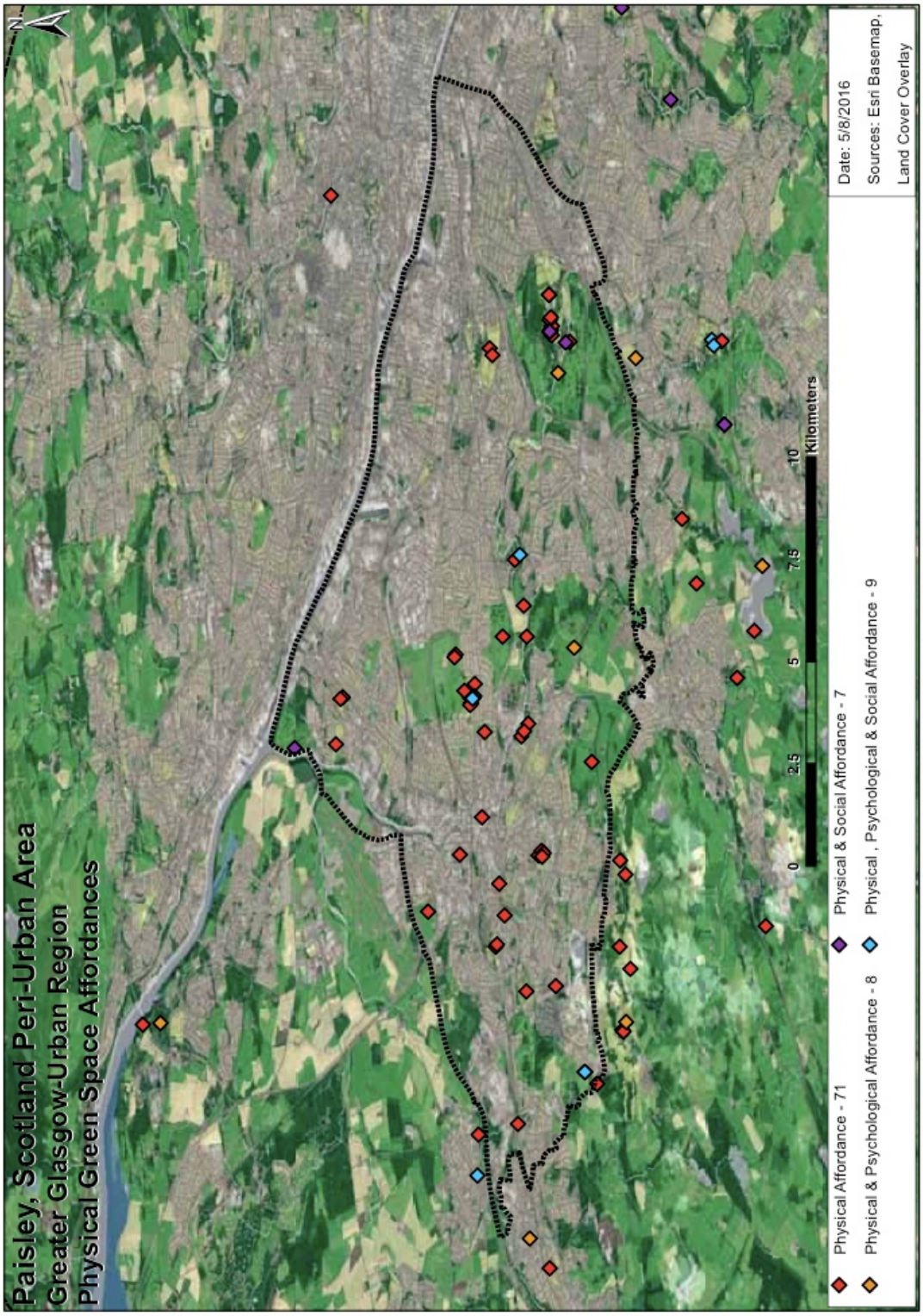


Figure 9.46
Physical HWB Affordance Locations– Paisley CA
Each geomarker as represented by the coloured diamond symbol represents a specific HWB affordance or group of HWB affordances.

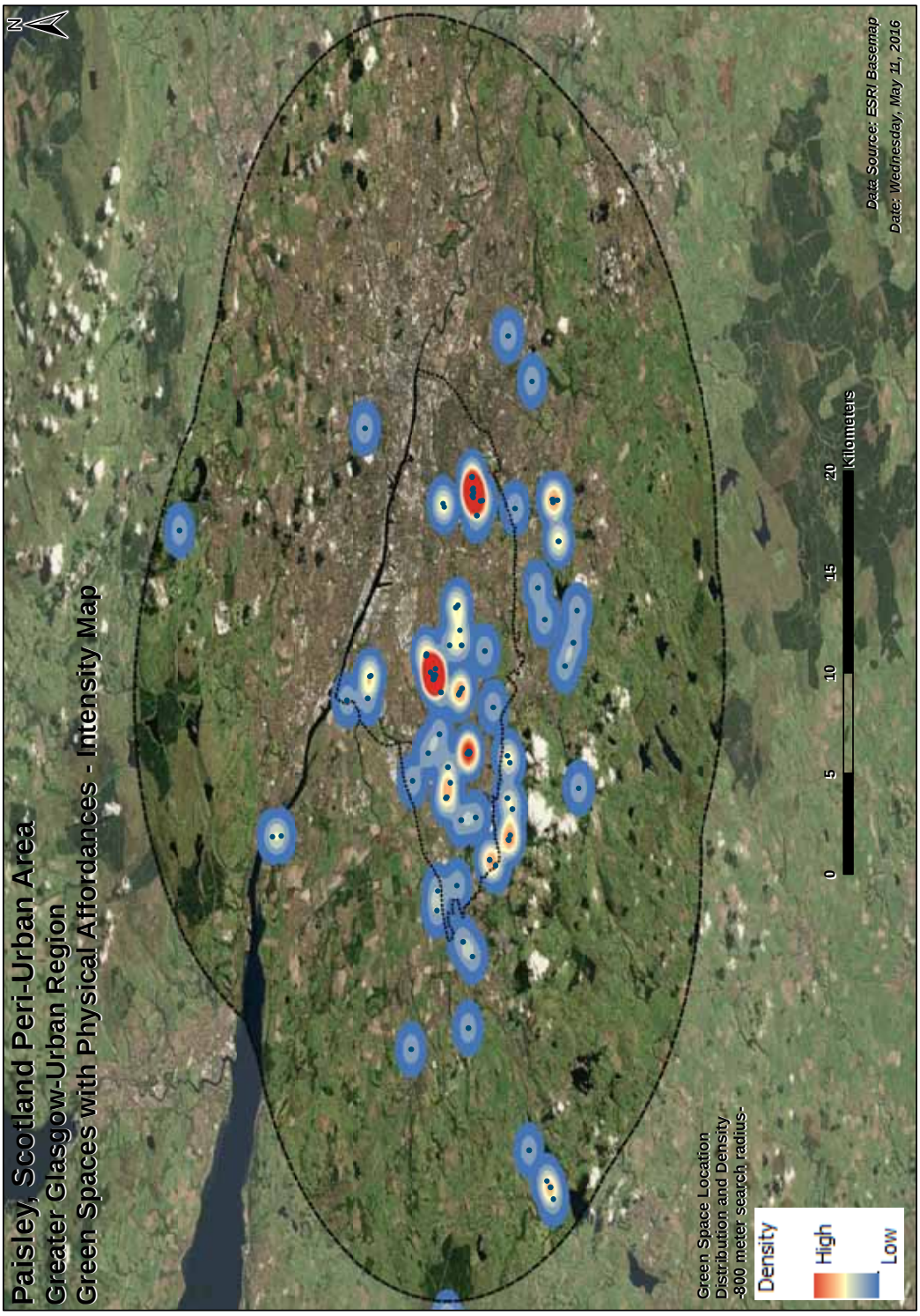


Figure 9.47
Physical HWB Affordance Locations Heat Map – Paisley CA

Many of these PPUIGS identified provided only Physical HWB Affordances to the respondent.

n=5
Pollock Park

n=4
Barshaw Park
Glennifer Braes Country Park

n=3
Brodie Park
GS near Foxbar Road
Robertson Park

n=2
Maxwell Park
Renfrew Golf Club

n=1
Varied among the remaining 48 GS

Figure 9.48
Physical HWB Affordance GS Frequencies – Paisley CA

These results were not surprising given the Typology and implied use within the Name of the GS (e.g. Golf Club, Park). Pollock Park is the largest in the CA and Glennifer Braes is the largest in the Region. What was surprising is that only one golf course was listed by two respondents.

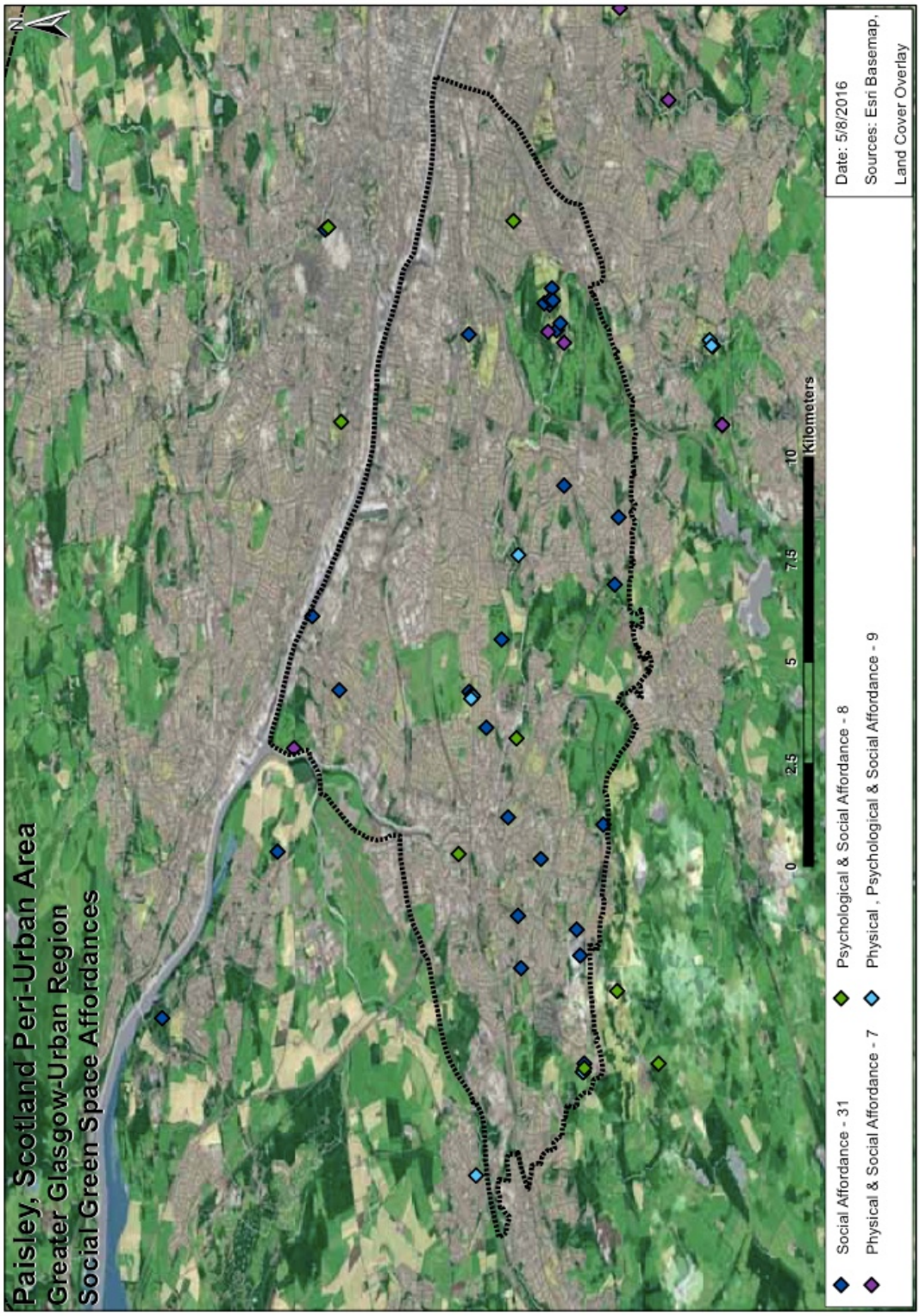


Figure 9.49
Social HWB Affordance Locations – Paisley CA

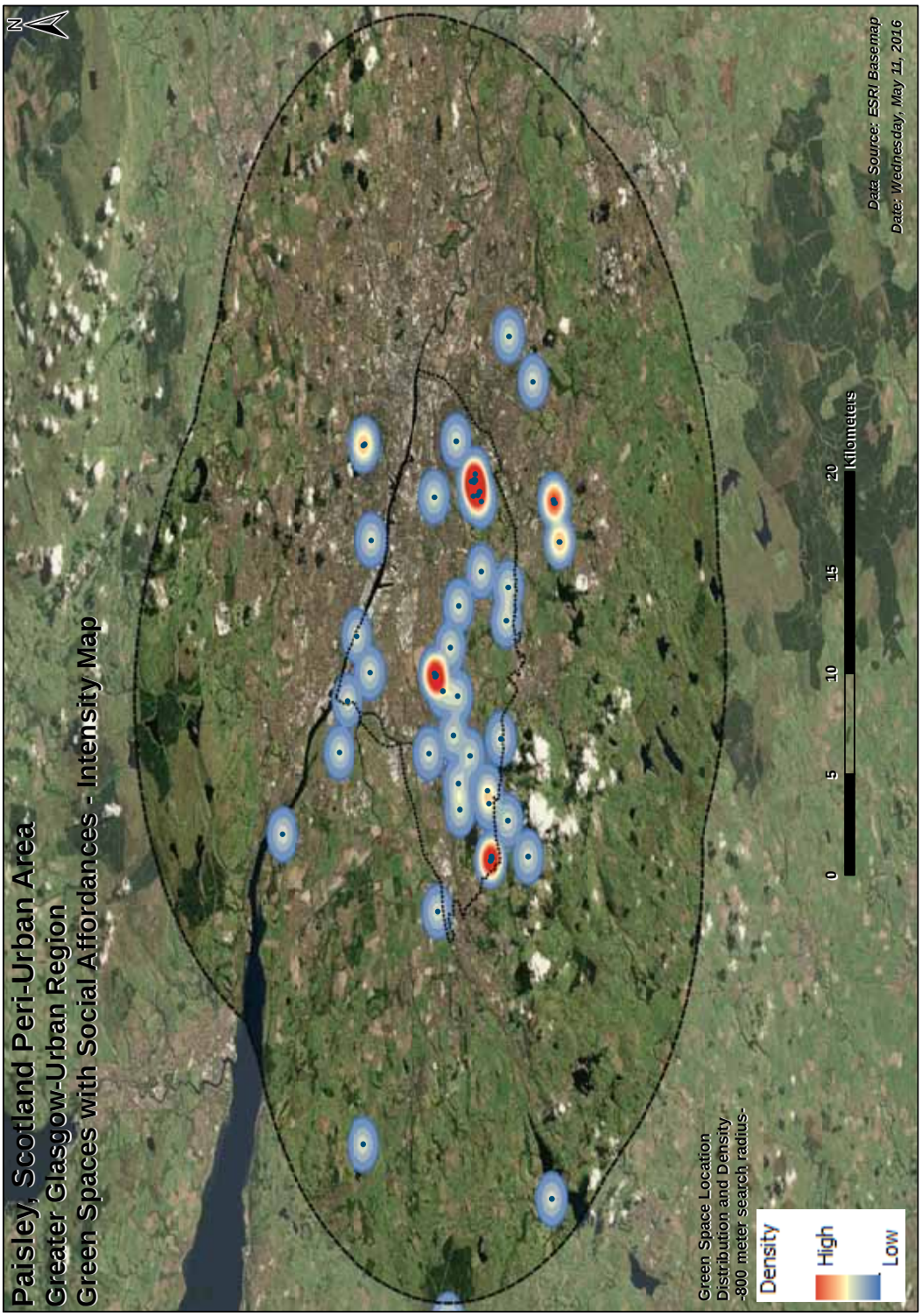


Figure 9.50
Social HWB Affordance Locations Heat Map – Paisley CA

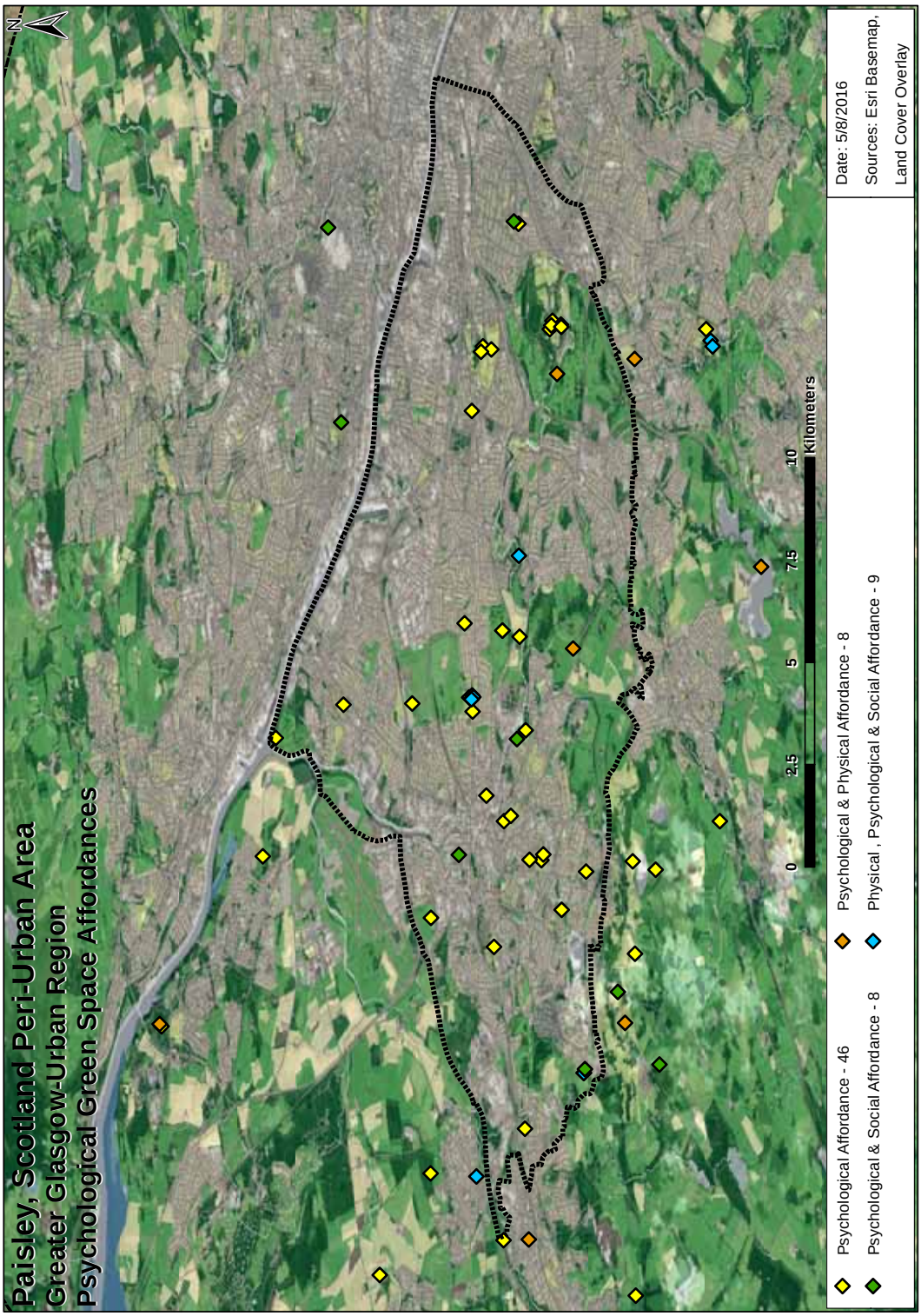


Figure 9.51

Psychological HWB Affordance Locations – Paisley CA

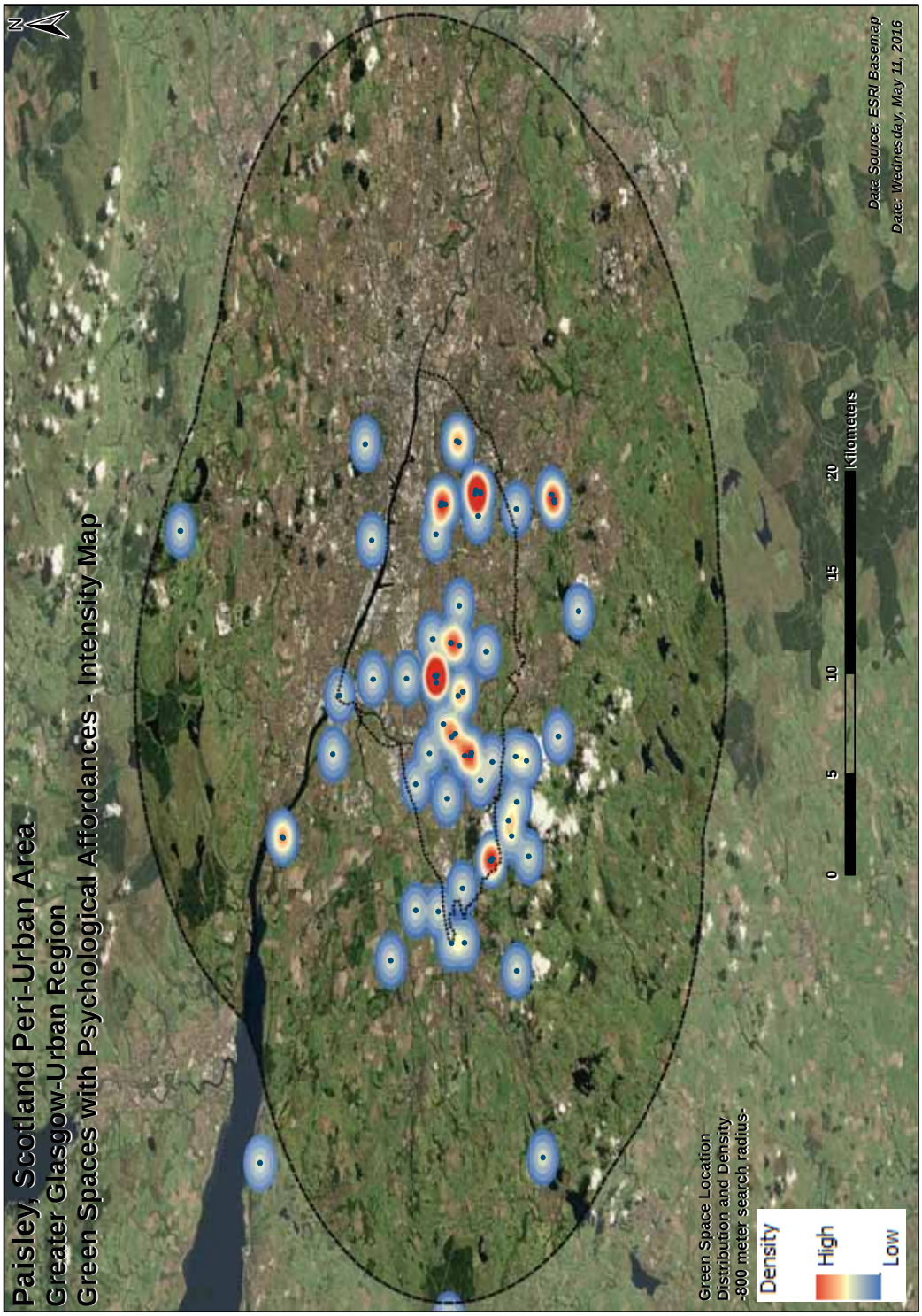


Figure 9.52
Psychological HWB Affordance Locations Heat Map – Paisley CA

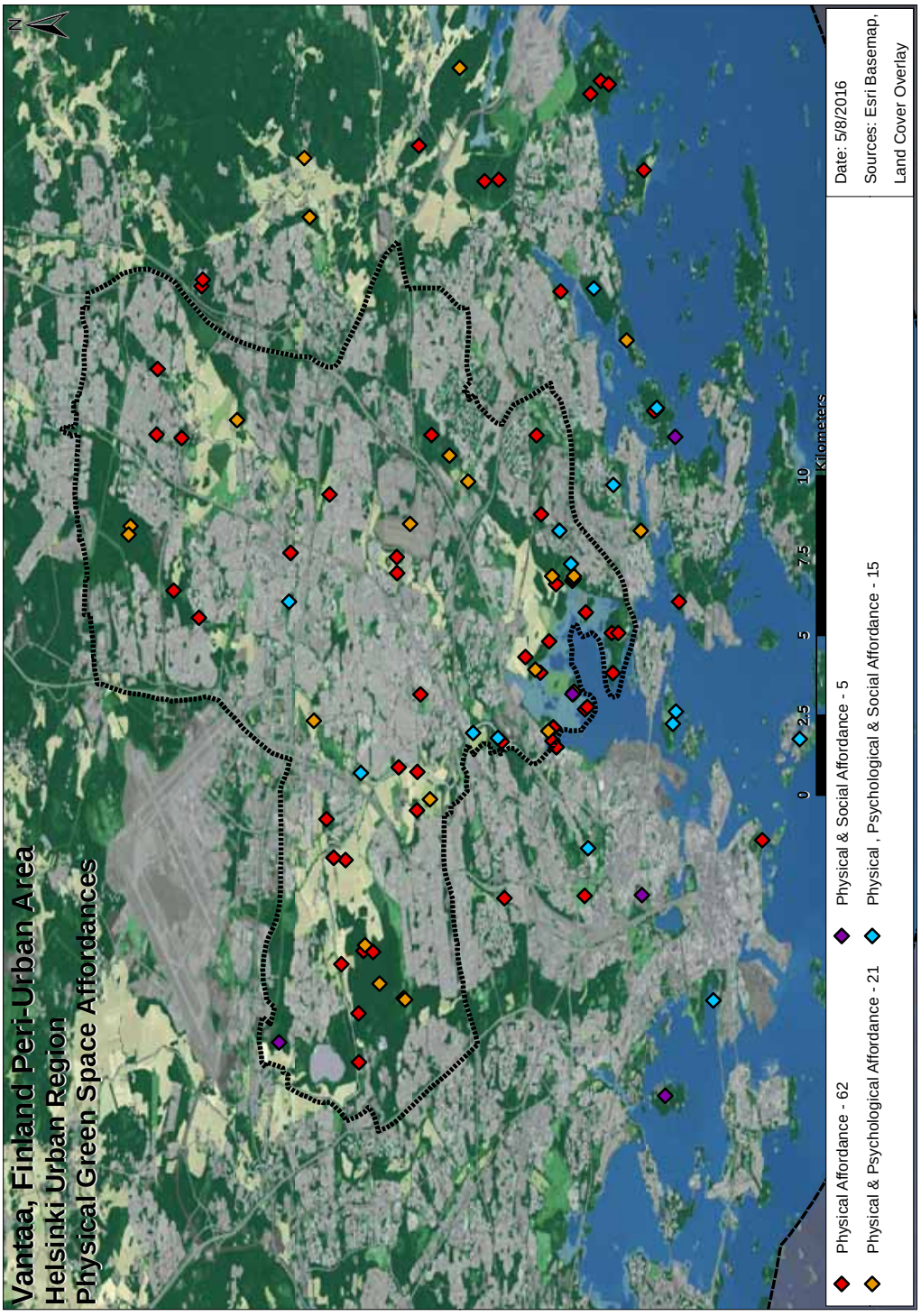


Figure 9.53
Physical HWB Affordance Locations– Vantaa CA

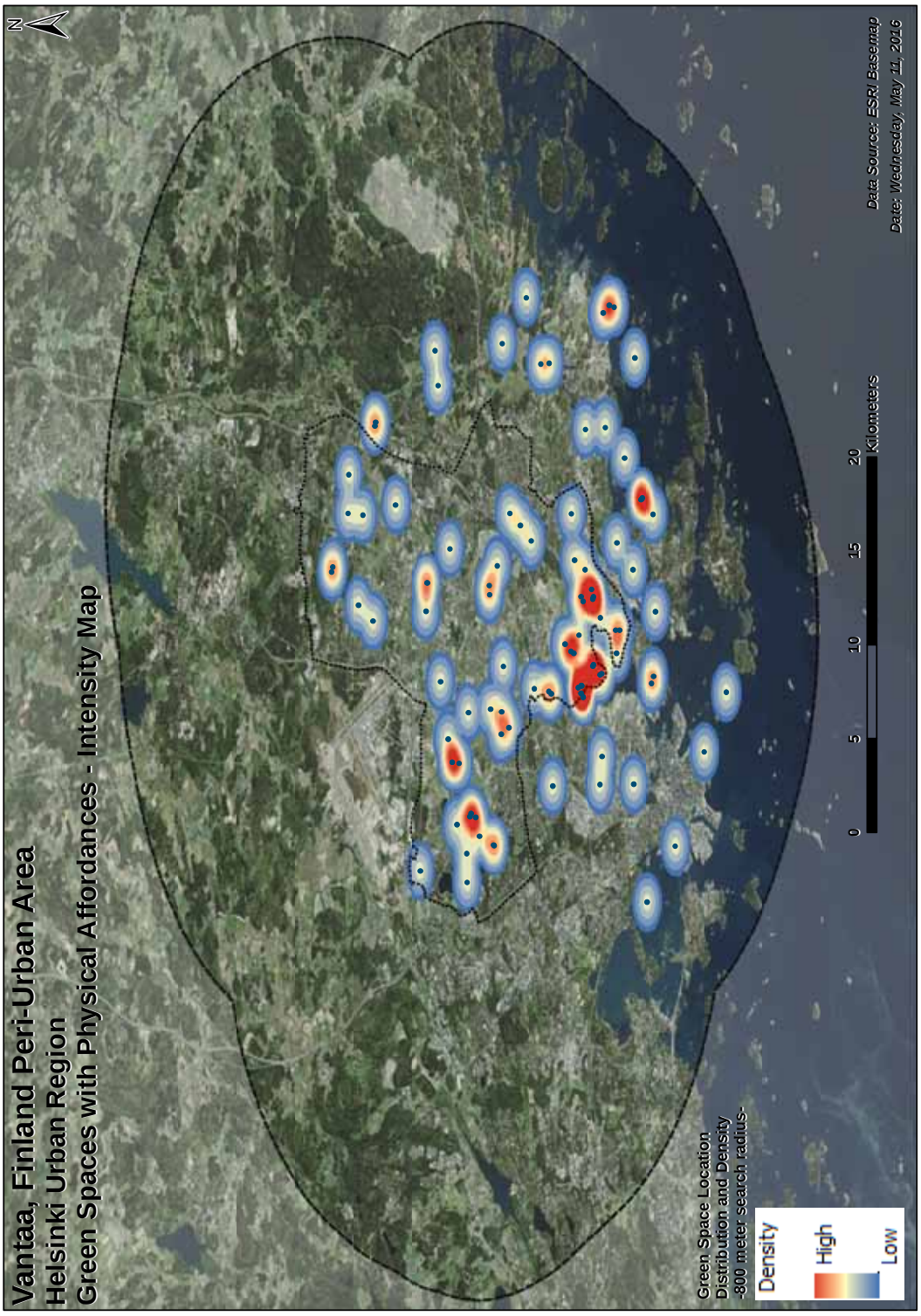


Figure 9.54
Physical HWB Affordance Locations Heat Map – Vantaa CA

Many of these PPUIGS provided only Physical HWB Affordances to the respondent.

n=4
GS near Toyrynummi

n=3
Helsinki-Malmi Airport
Trailway at Vantaa River
GS near Rekolanmaki
GS near Latokartano
GS along Karava River near GS18

n=2
Beach at Crussell Bridge
Tuomarinkyla Estate
GS near Paloheina

n=1
Playing Field near Tapulikaupunki
Landfill Mound at Sampola Activity Center
Hietaniemi Cemetery
GS along Karava River near Suutarila
GS Ag Field at Vantaa River
Paloheina Golf Course
Community Garden at Vantaa River
GS near Ritsipuro
GS near Hakalanniemi
GS near Grotens
Malminkartano Hill
GS Corridor near Lammassaari Island
GS Corridor near Haltiala Farm
Park near Longinoja River
GS near Tapaninkyla
Brubacka Park
Savelan Freestylepark
Malmin Cemetery
GS near Heureka
Anenome Grove
GS near Kastaankartano
GS near Kyntelikuja Street
GS on Karhusaari

Figure 9.55

Physical HWB Affordance GS Frequencies – Vantaa CA

These results were not surprising given the Typology and implied use within the Name of the GS (e.g. Playing Field, Beach, Golf Course). Those without such qualifiers were primarily Linear GS, a characteristic conducive to physical activity.

What was interesting was the four sole Physical Affordance for the geo-marker *'GS near Toyrynummi' (n=4).* This GS is a grassland with a mixed, natural vegetation setting and is both grouped and connected to other nearby GS though it has an irregular shape with dense and numerous edges. This GS includes many of the fragmentation characteristics for the region's GS. This GS is one of the few (n=11, 9.7%) which contained unsafe characteristics, however it was evenly visited (n=2) by both males and females. Though this GS is very close to a major highway, it is also adjacent to a large housing area. This GS also borders a linear trail along the Vantaa River. As with most of the geo-located markers provided by the respondents though it's scalable imagery interface, particularly in un-named and ambiguously defined GS, this GS's geo-markers in particular may have been intended for other GS nearby and/or contiguous.

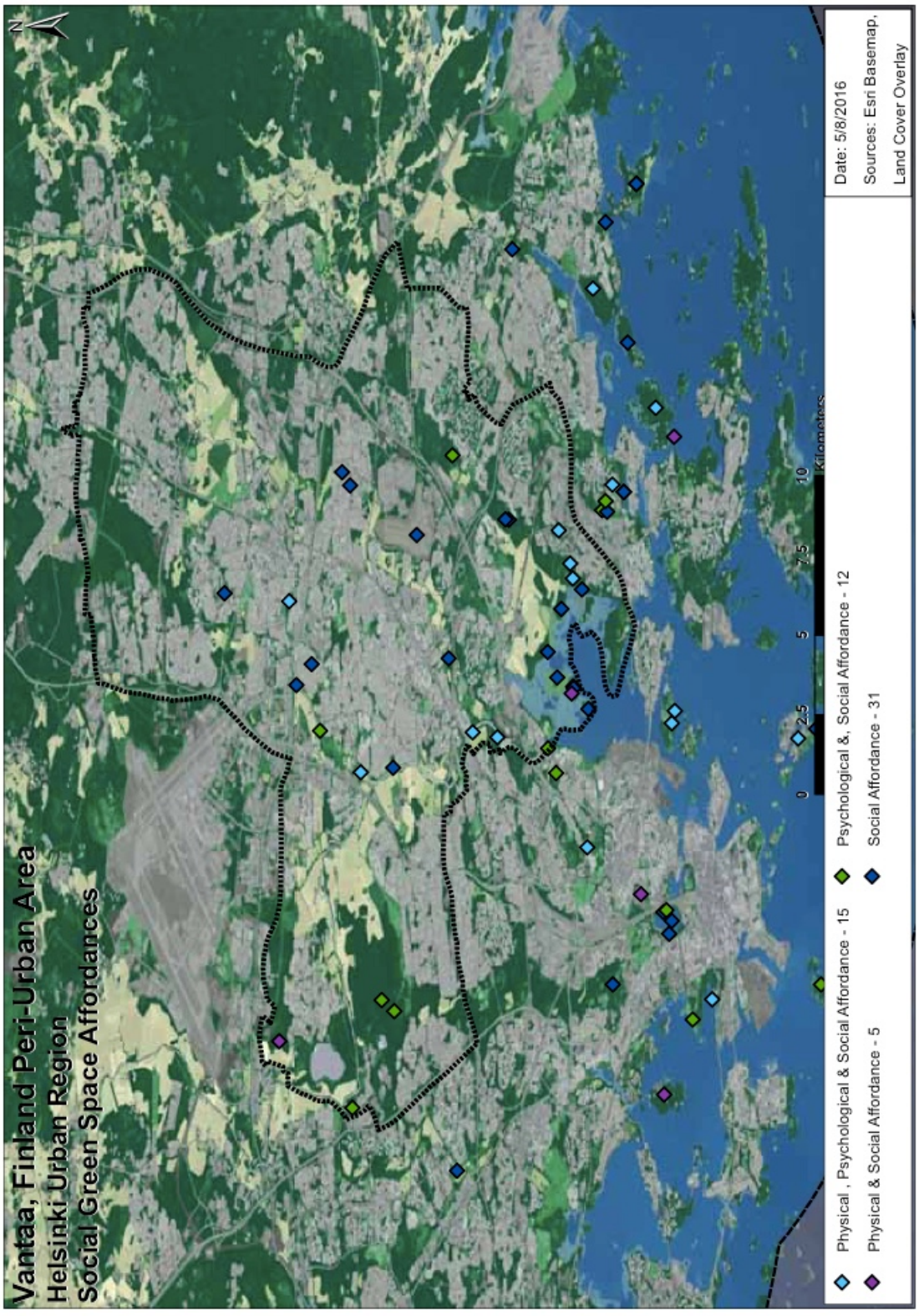


Figure 9.56

Social HWB Affordance Locations – Vantaa CA

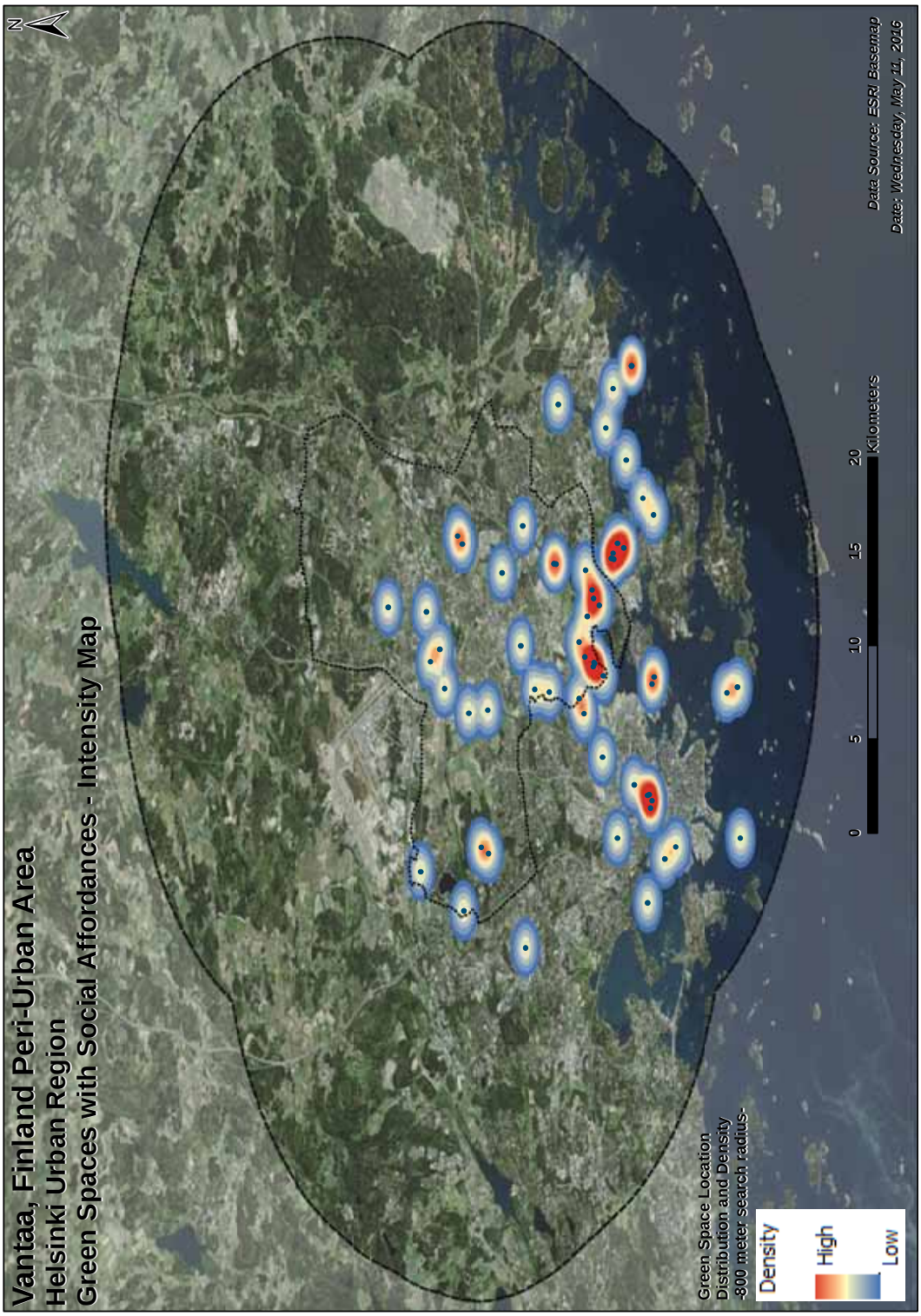


Figure 9.57

Social HWB Affordance Locations Heat Map – Vantaa CA

As expected due to limited overall number of Social HWB affordance geo-markers, a few of these GS provided only Social HWB Affordances (n= 31, Figure 9.58), each one identified by only one respondent (n=1), and these singular geo-markers (n=11) accounted for 18% of all Social HWB Affordance geo-markers:

n=2
Suomenlinna Island

n=1
Little River Beach
Community Gardens near 101
Kallahti Beach
Vallila Community Gardens
Kapyla Sports Park
Playground Linnunrata, Suutarila
GS near Puistola Library
GS near Puistola Community Gardens
GS in Kartanonkoski Village
Kartanonhaka Park
Hietaniemi Beach

Figure 9.58

Social HWB Affordance GS Locations Frequencies – Vantaa CA

It is interesting to note that of all the GS which contained a 'Beach' qualifier to it (n=6), all were noted as providing a Social HWB benefit, with 4 of those 6 being Social HWB benefit solely.

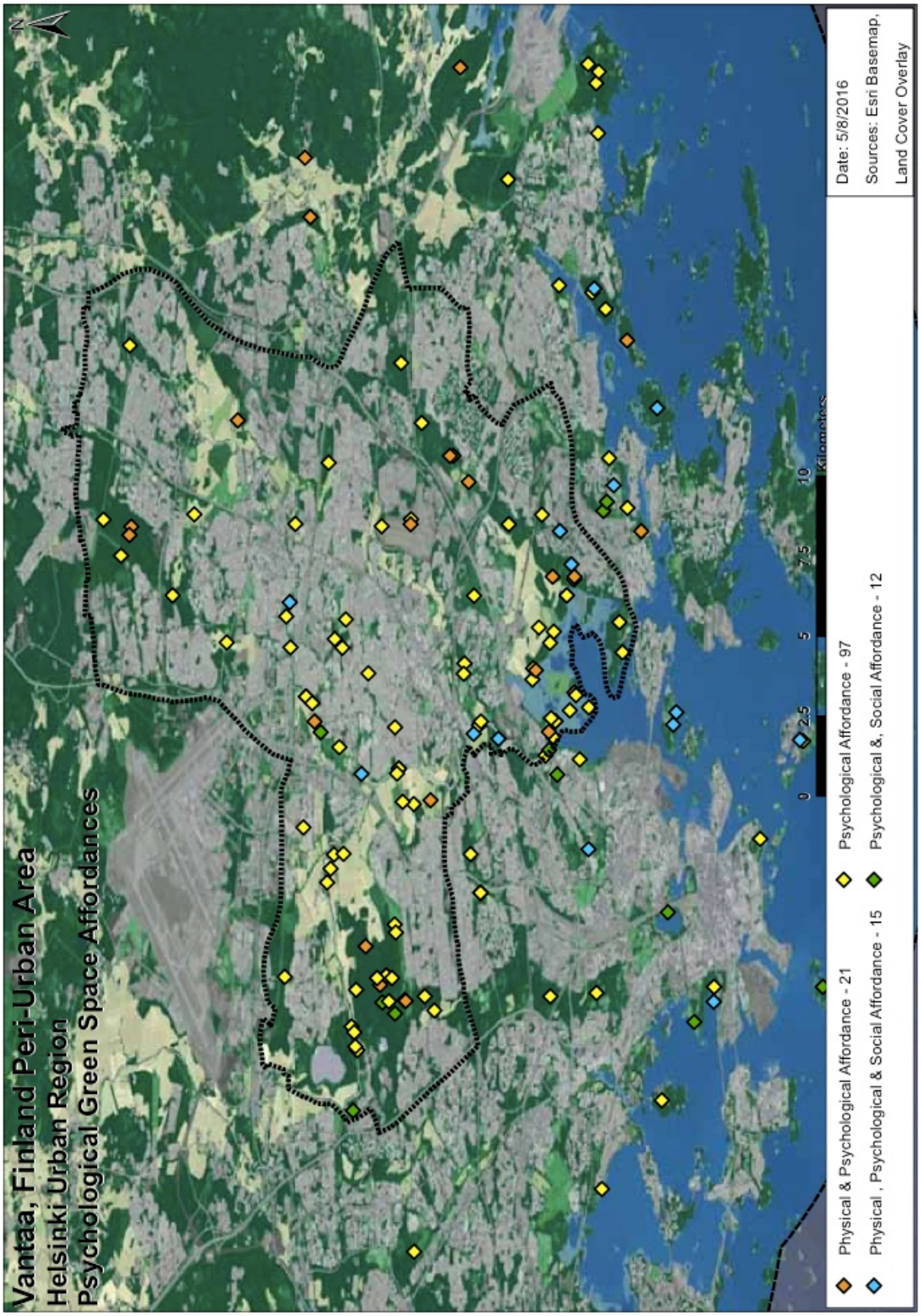


Figure 9.59

Psychological HWB Affordance Locations – Vantaa CA

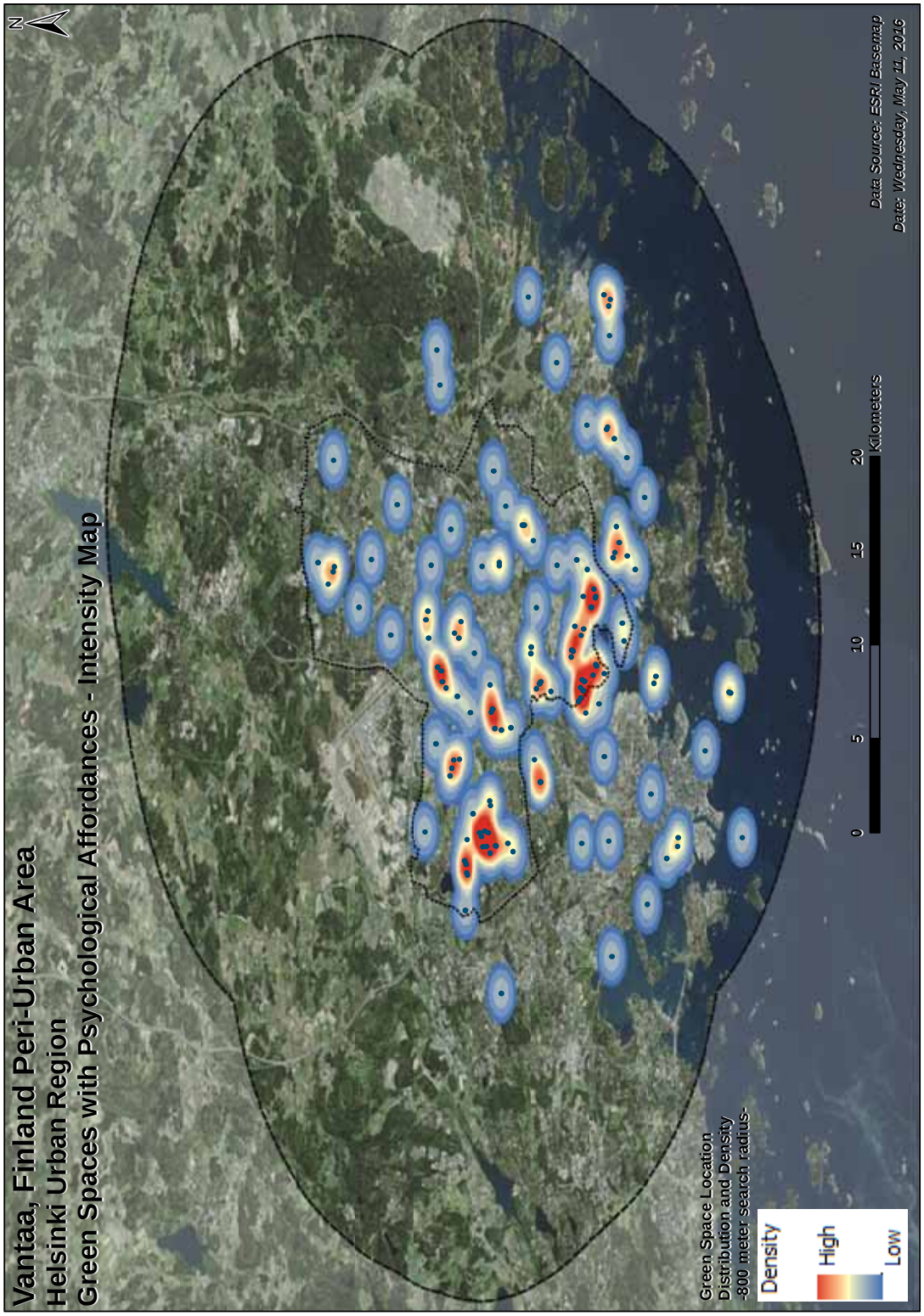


Figure 9.60
Psychological HWB Affordance Locations Heat Map – Vantaa CA

Many of these GS provided only Psychological HWB Affordances.



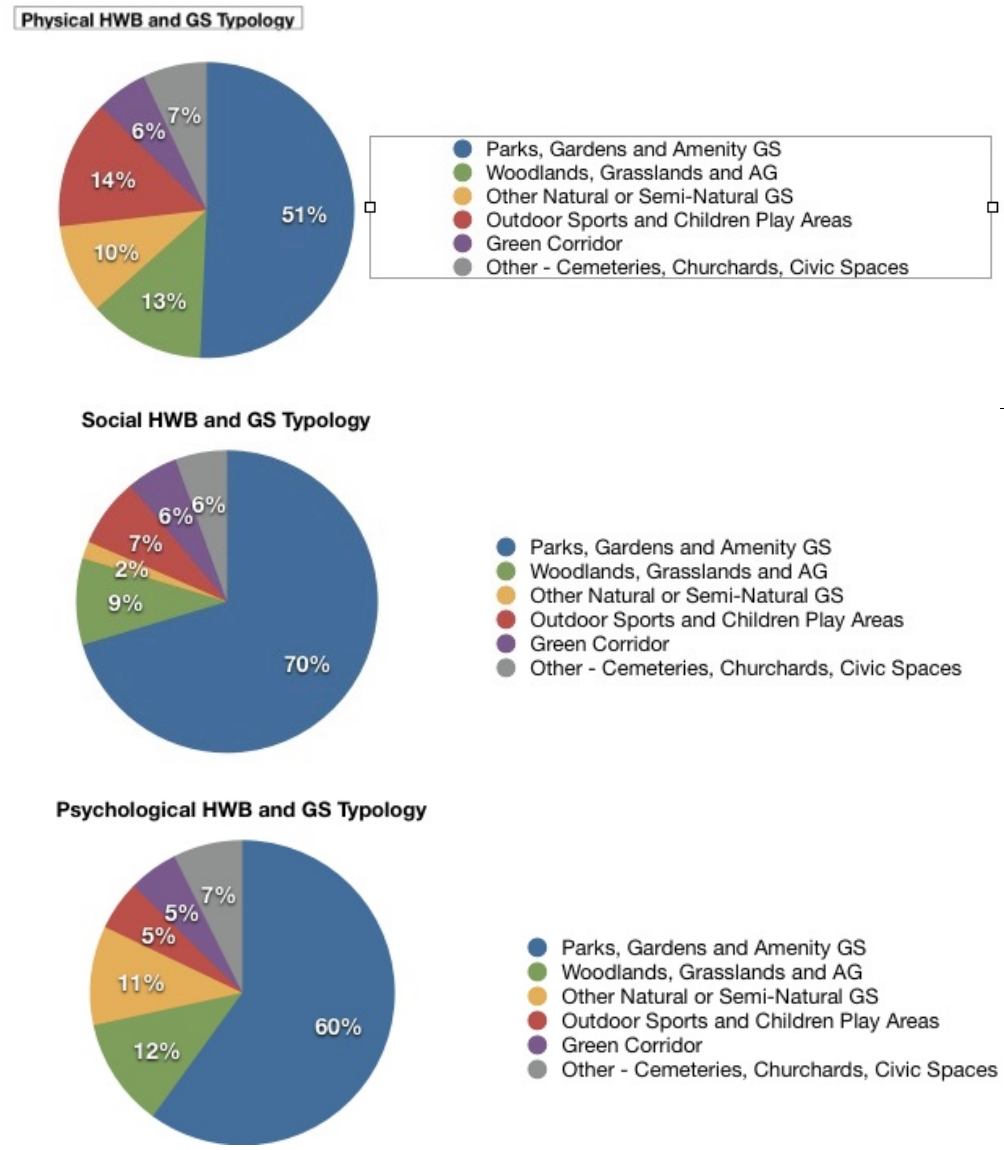
Figure 9.61

Psychological HWB Affordance GS Locations – Vantaa CA

GS Typology and HWB Affordance

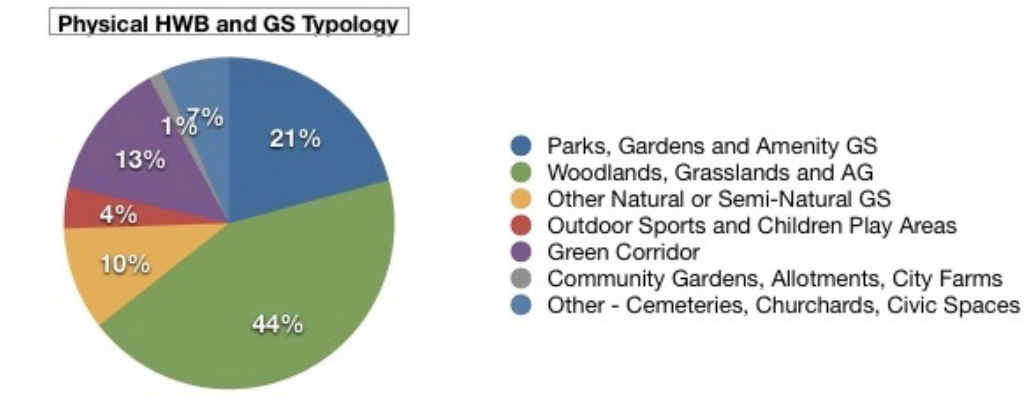
Building from the overall frequency of GS HWB affordances reported, PPUIGS are similarly utilised for specific HWB affordances in each CA. The only noted difference from ovearall GS affordances typologies is within the Vantaa CA, Parks, Gardens and Amenity GS were the predominant provider of Social HWB affordanes (34%) though Woodlands, Grasslands and Agricultural were closely second most frequent (27%).

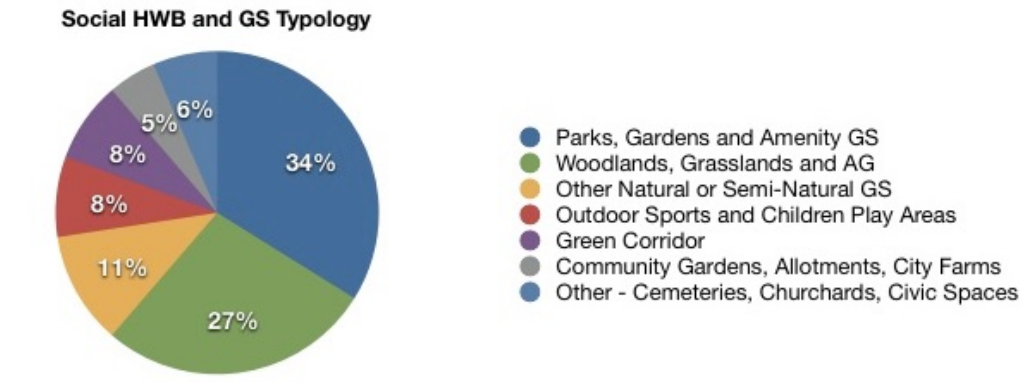
It is important to note those GS typologies whice received zero affordance geomarkers. Within the Paisley CA, no Community Gardens, Allotments and City Farms were selected a providing a HWB affordance through the respondents geomarkers.

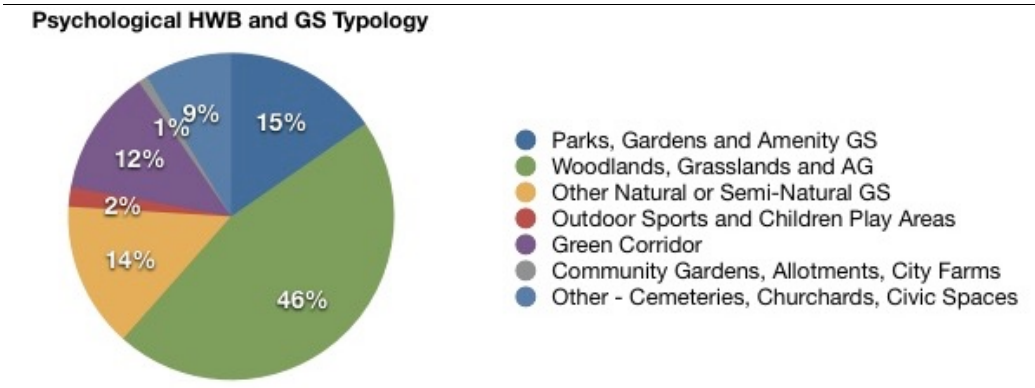


Paisley CA	Parks, Gardens and Amenity GS	Woodlands, Grasslands and AG	Other Natural or Semi-Natural GS	Outdoor Sports and Children Play Areas	Green Corridor	Other - Cemeteries, Churchards, Civic Spaces
Physical HWB	36	9	7	10	4	5
Social HWB	38	5	1	4	3	3
Psychological HWB	57	11	10	5	5	7

Figure 9.62
GS Typology and HWB Affordance
Paisley CA







Vantaa CA	Parks, Gardens and Amenity GS	Woodlands, Grasslands and AG	Other Natural or Semi-Natural GS	Outdoor Sports and Children Play Areas	Green Corridor	Community Gardens, Allotments, City Farms	Other - Cemeteries, Churchards, Civic Spaces
Physical HWB	31	65	15	6	20	2	10
Social HWB	21	17	7	5	5	3	4
Psychological HWB	16	48	15	2	13	1	9

Figure 9.63
GS Typology and HWB Affordance
Vantaa CA

9.5.3.2 HWB Affordances and PPUIGS Characteristics

This section further describes and compares the frequency results for the relationship between the PPUIGS eco-spatial characteristics and HWB affordances. Each PPUIGS geomarker within the SQ had HWB data associated with it – what type of affordance they received from interaction with that PPUIGS. Each geomarker was analysed post-hoc to determine each PPUIGS's eco-spatial characteristic levels within the PPUIGS Characteristics Measurement Index – Table 7.30 with summaries and comparison results noted below.

For reference and descriptive clarification of the measurement levels (i.e. Vegetation Structure = 1. Diverse and Random, 2. Clustered, 3. Uniform) discussed in this section, refer to Figure 9.63A: Landscape of Affordance Characteristics Levels and Descriptions. These descriptions are those PPUIGS Chracteristics, Attributes and Levels found within the PPUIGS Characteristics Measurement Index – Table 7.30 and their descriptions, below, are specific to HWB benefits (See Chapter 5). These characteristic and descriptions are also supported through diagrams, satellite images, and other imagery/photographs later in this Thesis as required.

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS ATTRIBUTE LEVELS and DESCRIPTIONS
SIZE	AREA	**Extensive** - green structure separates houses well, not see other houses within green structure or at green structure edges **Moderate** - green structure separates houses somewhat **Limited** - from green structure edge, one can see houses across from them
SIZE	DENSITY	**High Density** - green structure is seen nearby **Moderate Density** - green structure is seen at a distance but not nearby **Low Density** - green structure is not seen at all
SIZE	LARGEST	**Largest** - green structure is very large and is the largest (>75%) in the catchment area **Moderate** - green structure is normal sized when compared to others (in CA)(25%-75%) **Small** - green structure is very small and is the smallest (<25%) in the catchment area
SHAPE	SHAPE - REGULATION	**Regular** - green structure is regularly shaped with mostly evenly-spaced and/or evenly-lengthed sides (rectangle, square, or mostly equilateral polygon - a circle or semi-circle is considered regular) **Moderate** - green structure is somewhat regularly shaped and, overall, most parts are regularly and evenly shaped with a few angled corners and possibly some linear and narrow portions. **Irregular** - green structure is not regularly shaped with many uniquely-angled corners and very few if any any similarly-spaced or similarly-lengthed sides **Linear** - green structure is considered a linear corridor such as a national bike path or river walkway
SHAPE	COMPLEXITY and DIVERSITY	**Complex** - green structure is complex and diverse in shape. There are many sides (8+) and unique angles (e.g. 0-30deg, 110deg+) **Moderate** - green structure is neither complex nor simple in shape (4-8 sides). Somewhat regularly shaped. **Simple** - green structure is simple and uniform in shape (3-4 sides). It is very regularly shaped. **Linear** - the green structure is a linear corridor with a few larger areas (parking, amenities) along route.
SHAPE	TYPOLOGY	*If the green structure has a mixed spatial quality to it, the dominant portion or most used portion determines level* **Natural** - green structure feels wild and natural, sense of ruralness to it (e.g. Woodlands) **Moderate** - green structure feels neither natural or urban (e.g. Agricutlural and Grazing lands) **Urban** - green structure feels urban, not very natural or rural at all (e.g. Playing Fields, Civic Plaza, Monument)

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS ATTRIBUTE LEVELS and DESCRIPTIONS
PROXIMITY	NEAREST NEIGHBOUR	**Connected** - green structure is physically connected to another at least 1 side (no street, wall, fence - path ok) **Nearby** - one can see another green structure (50m minimum width facing) from most parts of the green structure, but not physically connected. A street, rail or wall/fence may separate the green structure. **Separated** - green structure is alone & separate, not physically or visually connected, cannot see another green structure from any parts of green structure
PROXIMITY	ISOLATION and CONNECTIVITY	*When viewed without land ownership boundaries:* **Grouped** - considered 1 in a group of many green structures nearby **Moderate** - considered 1 in a group of few green structures nearby **Isolated** - only green structure, none in nearby group
EDGE	TOTAL EDGE (Quantity)	**Numerous** - green structure has many edges (8+) **Moderate** - green structure has a moderate amount of edges (4-8) **Few** - green structure has few edges (3-4)
EDGE	LONGEST EDGE (Length)	**Longest** - green structure has some or a very long edge, longest in area **Moderate** - green structure has normal edge sizes when compared to others **Least** - green structure has some or a very short edge, shortest in area
EDGE	EDGE DENSITY (Vegetation or Structures)	*Edge Condition can be vegetation (trees, shrubs) and/or built structures (fence, wall, houses, etc)* **Dense** - dense edges, not very visible into green structure, blocks views into green structure **Moderate** - some edge areas offer visibility into green structure **Transparent** - very open edges, easily visible into green structure from outside-in or inside-out
ACCESSIBILITY	DISTANCE (WALK)	*For nearby neighbourhood(s):* **Close** - getting to the green structure requires a short walk (0-5 min or 0-400 m) **Moderate** - getting to the green structure requires a long walk (5-10 min or 400 - 800m) or bike **Far** - getting to the green structureGS requires a car or bus (over 10 minutes, over 800m)
ACCESSIBILITY	DISTANCE (CAR/BUS)	*For nearby neighbourhood(s):* **Close** - getting to the green structure requires a short vehicular ride (0-2 km) **Moderate** - getting to the green structure requires a moderate ride (2-5 km) **Far** - getting to the green structure requires a long vehicular ride (5+km)

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS ATTRIBUTE LEVELS and DESCRIPTIONS
ACCESSIBILITY	DISTANCE (LEVELS OF)	**Full Access** - entry to the green structure is possible without restriction. **Conditional Access** - a right of entry exists which is subject to or affected by one or more restrictions or conditions (e.g. hours, pass requirements, permitted use restrictions, etc) **Remote Access** - no physical right of access exists (e.g. gates, fence, wall), but the green structure provides a visual green resource whether viewed close or at a distance
GREENESS	VEGETATION COMPOSITION	**Deciduous** - green structure with predominately deciduous vegetation types **Evergreen** - green structure with predominately evergreen vegetation types **Mixed** - green structure with a fair mixture of different (evergreen and deciduous) vegetation types green structure **Play fields or Grass** - green structure which is a playing field or a grass area (including grazing and agricultural or farming fields)
GREENESS	VEGETATION COMPOSITION - SETTING *(May have 1 or more of the following:)*	*Regardless of facilities or amenities including paths, lights, bins, benches, centres, toilets:* **Natural** - green structure is very natural and has no informal recreation opportunities (beyond trail walking, wildlife viewing, etc), a wide variety of vegetation types and/or types of habitats and with predominately natural or naturalistic vegetation. Green structure lacks a formal composition and may have a 'wild' feeling to it. **Semi-Natural** - green structure still has a natural feeling to it and a few informal recreation opportunities (beyond trail walking, wildlife viewing, etc) with a variety of vegetation types or limited types of habitats and with some natural or naturalistic vegetation or areas. Agricultural Fields and Grazing Lands are often considered of this Setting. **Semi-Urban** - green structure has a few informal and at least one formal recreation area. There is a good mixture of both formal and informal plantings and habitat or vegetation types. Some large, manicured grassed areas. **Urban** - green structure has mostly formal recreation opportunities. Vegetation types may be varied but are managed heavily and/or predominately ornamental vegetation varieties. There may be many formalised, manicured grassed areas. There may be many formal plantings. Play fields are often considered of this Setting.

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS ATTRIBUTE LEVELS and DESCRIPTIONS
GREENESS	VEGETATION STRUCTURE - HORIZONTAL *(not dependent upon vegetative composition)*	*Deciduous and/or Coniferous Vegetation Types, Vertical is under 4' height:* **Diverse and Random** - green structure with many different horizontal vegetation types whose diversity is visually dominant. Distribution is many and informal/wild. **Clustered** - a few or many different horizontal vegetation types, but not present in all areas of green structure. Horizontal vegetation is distributed only in clumps or massed planting areas. **Uniform** - green structure with hardly any or different horizontal vegetation types (e.g. play fields, mown grass parks). Little horizontal vegetation distribution within GS.
GREENESS	VEGETATION STRUCTURE - VERTICAL *(not dependent upon vegetative composition)*	*Deciduous and/or Coniferous Vegetation Types, Vertical is over 4' height:* **Diverse and Random** - green structure with many different vertical vegetation types whose diversity is visually dominant. Distribution is many and informal/wild. **Clustered** - a few or many different vertical vegetation types, but not present in all areas of green structure. Vertical vegetation is distributed only in clumps or massed areas. **Uniform** - green structure with hardly any or different vertical vegetation types (e.g. allees, walkways). Little vertical vegetation distribution within green structure (many open spaces). None visually dominant.
GREENESS	VEGETATION STRUCTURE - DENSITY *(not dependent upon vegetative composition)*	*Deciduous, Mixed and Coniferous Vegetation, Horizontal and Vertical, Considered Spatially:* **Dense** - within green structure, many dense or clustered plantings, crowded and tightly-packed. **Moderate** - within green structure, both dense and sparse areas **Open** - within green structure, sparse plantings, few plantings, spacious (mostly grass areas, play fields).
GREENESS	VEGETATION STRUCTURE - VISIBILITY	**Extensive** - within green structure, many (3+) long and expansive views, within green structure and/or out from green structure **Moderate** - within green structure, a few (1-3) extensive views, some areas with limited visibility **Limited** - within green structure, no long or expansive views either within green structure or out from green structure, limited visibility
GREENESS	VEGETATION STRUCTURE - SLOPE	**Steep** - within green structure, many steep and non walkable slopes. **Moderate** - within green structure, a few moderate and challenging slopes. **Flat** - within green structure, generally flat and easily manoeuvrable

PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS ATTRIBUTE LEVELS and DESCRIPTIONS
GREENESS	PROXIMITY TO HEAVY TRAFFIC ROAD	**Close** - the green structure is directly adjacent to heavy traffic road (M, A or 4-Lane Road) **Moderate** - one can see or hear traffic road within green structure (M, A, B or 4-Lane Road) **Far** - no heavy traffic road in in visual or aural proximity of green structure
MAINTENANCE AND MANAGEMENT	CLEANLINESS	**Clean** - green structure is well maintained or managed. Pavement is not cracked, vegetation is trimmed, grass is mowed often. Not many exposed dirt areas, no dog fouling. No graffiti or rubbish seen outside bins. Benches are clean and sturdy. 'Tidy' green structure. **Moderate** - green structure adequately maintained, some dirty areas. **Dirty** - green structure not well maintained or managed, messy. Pavement cracking and limited grass and vegetation maintenance. If present, buildings and structures/amenities not well maintained or clean. Rubbish and graffiti may be seen. Not a 'Tidy' green structure.
MAINTENANCE AND MANAGEMENT	FACILITIES (AMENITIES)	**Abundant** - green structure has many facilities and/or user amenities (e.g. benches, tables, paved areas, toilets, drinking fountain, signage, cafe, bins, etc) throughout. **Adequate** - green structure has a good amount of facilities and/or user amenities **Inadequate** - green structure has few facilities and/or user amenities
MAINTENANCE AND MANAGEMENT	FACILITIES (PATHS)	*NOT quality of pavement or paths, not maintenance level - only provision of paths:* **Paved** - nearly all paths are paved (non-porous) **Mixed** - some non-paved trails and walking tracks & some paved paths and walking/cycling areas **Unpaved** - no paved paths or trails
MAINTENANCE AND MANAGEMENT	FACILITIES (SOCIABILITY)	**High** - the green structure has exposed spaces with many places for social interaction, both formal & informal. There is a designated dog space. Many benches and seating areas, possibility of a playground or communal area. green structure can accommodate large groups. **Mixed** - the green structure has both exposed and communal spaces and more solitary and alone spaces. Not many communal areas but still some spaces for large groups. **Low** - the green structure has mostly solitary and isolated spaces. Not many benches or tables.
SAFETY AND SECURITY	SAFETY and SECURITY	*Presence of lighting, locked gates, open edges, visibility/eyes-on, management:* **Safe** - many lights and open edges, visibility within and throughout is high. **Somewhat Safe** - some lights and/or some edges are open. Visibility is acceptable at some places. **Unsafe** - minimal or no lights, enclosed and dark edges, low visibility. Many dark areas.

Figure 9.63A
Landscape of Affordance Characteristics Levels and Descriptions

PPUIGS Size Characteristics and Attributes Influencing HWB

Size – Area

Consistent between CAs, it was extensive GS that separates housing or buildings for all HWB affordances.

Size – Density

Although Paisley's respondents most often utilised GS with a high density, in that other GS are seen nearby for all HWB benefits, Vantaa's respondents visited social and psychological HWB GS with only a moderate density where GS is seen in the distance, not necessarily physically contiguous or nearby.

Size – Largest

Although both sets of respondents most often utilised GS considered a normal size within the overall CA for all HWB benefits, Vantaa's respondents visited the largest sized GS for physical HWB benefits.

PPUIGS Shape Characteristics and Attributes Influencing HWB

Shape – Regulation

Whereas Paisley's respondents most often utilised regular-shaped GS to achieve most HWB benefits, Vantaa's visited irregular-shaped GS.

Shape – Regulation – Greenness

Although both sets of respondents predominately visited natural-shaped GS for all HWB benefits, Paisley respondents visited urban-shaped GS for physical HWB benefits.

Shape - Complexity and Diversity

Whereas Paisley respondents visited simply-shaped and uniform GS for all HWB benefits, Vantaa respondents visited moderately-complex shaped GS for HWB benefits.

PPUIGS Proximity Characteristics and Attributes Influencing HWB

Proximity - Nearest GS Neighbour

Both CA respondents visited GS that were physically connected to another GS in

order to achieve HWB benefits.

Proximity - Isolation and Connectivity

Both CA respondents visited GS that were considered part of a larger group of GS nearby in order to achieve HWB benefits.

Proximity - Level of Coherence

This characteristic reported differences for each CA. Whereas Paisley respondents visited autonomous or independently situated GS for physical-based and social-based HWB benefits, Vantaa respondents visited integrated or GS spatially inclusive or a larger GS for these same HWB benefits. Both CAs visited integrated GS for psychological-based HWB benefits.

PPUIGS Edge Characteristics and Attributes Influencing HWB

Edge - Total Edge

This characteristic reported differences for each CA. Although respondents in both CAs visited moderately-edged (n=4-8) GS for social-based benefits, Paisley respondents, generally, visited numerously-edged (n=8+) GS for physical-based HWB benefits, whereas Vantaa respondents visited moderately edged GS. Additionally, Paisley respondents visited moderately edged GS for psychological-based HWB benefits whereas those in Vantaa visited numerously-edged GS.

Edge - Longest Edge

Both CA respondents most often visited GS that had normal-sized edges when compared to other GS within the CA in order to achieve HWB benefits, however Vantaa respondents visited GS with very short edge lengths for social-based HWB benefits.

Edge - Edge Density

This characteristic reported distinct differences for each CA. Overall, Vantaa respondents interacted with dense GS edges at a higher frequency than Paisley. Paisley respondents most often visited moderately densely edged GS for physical HWB benefits, very densely edged GS for social HWB benefits, and transparently-edged GS for psychological HWB benefits. This contrasts with Vantaa respondents who visited densely-edged GS for physical and psychological benefits and

transparently-edged GS for social-based HWB benefits.

PPUIGS Level of Greenness Characteristics and Attributes Influencing HWB

Level of Green - Veg. Composition

This characteristic reported differences for each CA. Paisley respondents primarily visited deciduously-vegetated GS for physical and psychological HWB benefits, whereas Vantaa respondents received the same HWB benefits from mixed-vegetation (deciduous and coniferous) GS. Both CA respondents visited mixed-vegetation GS for social-based HWB benefits.

Level of Green - Veg. Composition - Setting

This characteristic was distinctly different for each CA. Whereas Paisley respondents mostly visited semi-natural composed GS for all HWB benefits, Vantaa respondents visited naturally composed GS for HWB benefits.

Level of Green - Vegetation Structure – Horizontal

Both CA respondents mostly visited GS that were considered consistent and regular in horizontal vegetation structure (i.e. grassed) in order to achieve HWB benefits.

Level of Green - Vegetation Structure – Vertical

This characteristic was different for each CA. Whereas Paisley respondents most often visited clustered vertical vegetation structured GS (i.e. massed and clumpy distribution of vegetation) for all HWB benefits, Vantaa respondents visited diverse and randomly-structured GS for physical and psychological-based HWB benefits.

Level of Green - Vegetation Structure – Density

Vantaa respondents' social-based benefits were most often received through visiting sparsely-planted GS whereas Paisley's were through densely-planted GS. This attribute's frequency was true for the physical-based HWB benefits as well, although open for Paisley and dense for Vantaa.

Level of Green - Vegetation Structure -Visibility

This characteristic was distinctly different for each CA. Whereas Paisley respondents visited GS with extensive visibility within them for all HWB benefits, Vantaa respondents visited limited-visibility GS for physical and psychological-based HWB benefits and moderate-visibility GS for social-based HWB benefits.

Interestingly, the only eco-spatial structural characteristic and level found to change within both samples (Each Individual CA's FGS, OGS, GS) was the Level of Greenness – Visibility aspect. This indicates that individuals do find Visibility to be an important aspect when selecting GS to interact with. Specifically, 51% (n=93) of the Paisley CA respondents interacted in GS with Extensive visibility (3+ long and expansive views) whereas 43% (n=105) of the Vantaa CA respondents interacted in GS with Limited visibility (Zero long and expansive views). This comparison requires further inquiry specific to the availability of Visibility aspects within each CA's GS. Overall, only 18% (n=45) of the Vantaa CA respondents reported GS containing Extensive Visibility levels, indicating the availability of Extensive Visibility GS to interact with was quite limited, overall. Similarly, 14% (n=25) of the Paisley respondents reported GS containing Limited Visibility levels. Thus, the results are not indicative of the overall Visibility GS characteristics available within each CA.

Level of Green - Proximity to Heavy Traffic Road

Consistent between CAs, GS which were close to or adjacent to a heavy-trafficked road were most often visited for all affordances.

These results indicate notable differences in the Level of Greenness Characteristics found within the GS interacted with between CA respondents. Paisley CA respondents most often interacted with a deciduous, semi-natural, open, vertically clustered GS with many extensive views. Vantaa CA respondents most often interacted with mixed deciduous and coniferous, natural, densely vegetated with a diverse and random structured GS with limited views. Interestingly, both CA respondents interacted with GS located close to a heavy trafficked road and with uniformly distributed horizontal vegetation.

PPUIGS Maintenance and Management Characteristics and Attributes Influencing HWB

Maintenance and Management - Cleanliness

Consistent between CAs, GS that were moderately-clean were most frequently visited for all affordances, though both respondent sets visited clean GS for social-

based HWB affordances.

Maintenance and Management - Facilities

This characteristic was distinctly different for each CA. Whereas Paisley respondents primarily visited GS with abundant facilities such as benches, tables and other amenities for all HWB benefits, Vantaa respondents visited adequately-facilitated GS for their HWB benefits.

Maintenance and Management – Facilities - Paths

This characteristic was distinctly different for each CA. Whereas Paisley respondents visited GS with paved pathways for all HWB benefits, Vantaa respondents visited GS with unpaved pathways for their HWB benefits.

Maintenance and Management – Facilities - Sociability

This characteristic was also distinctly different for each CA. Whereas Paisley respondents most often visited GS with high levels of sociability (i.e. gathering spaces, seating areas, etc.) for all HWB benefits, Vantaa respondents visited mixed-levels of sociability GS with both exposed and communal spaces as well as more private spaces for their HWB benefits.

Overall, these results indicate notable differences in the Maintenance and Management Characteristics found within the GS interacted with between CA respondents. Paisley CA respondents most often interacted with clean, highly sociable and abundantly facilitated GS with both paved and unpaved paths. Vantaa CA respondents, on the other hand, most often interacted with moderately clean, moderately sociable and adequately facilitated GS with mostly unpaved paths. These characteristics found within the Vantaa GS support their Greenness and Shape Characteristics of a more natural GS within a fragmented context.

This study did not correlate between the various GS characteristics and their use, only the benefits received from use. Thus, although other studies have shown that the presence of facilities can positively influence use (Giles-Corti et al., 2005a; Kaczynski et al., 2009), it is unclear within the context of this research whether or not this is the case. It was shown, however, that of the overall 426 GS markers within both sample groups, 296, or 70%, were to those with adequate or ample facilities.

PPUIGS Safety and Security Characteristics and Attributes Influencing HWB

Safety and Security

Whereas Paisley and Vantaa respondents mostly visited GS with safety and security levels considered somewhat safe for all HWB benefits, Vantaa respondents only visited GS with high levels of safety for their Social-based HWB benefits.

9.5.3.3 Multi-Affordance PPUIGS

This section breifly compares and contrasts the structural and non-structural landscape factors for those multi-functional HWB PPUIGS within each CA – those GS which provide more than one specific affordance of the three studuied (i.e. physical, social, psychological). This approach was different than that in the prior section and is considered less valid due to the very small sample sizes of those multi-functional PPUIGS (n=11 Paisley CA, n=27 Vantaa CA).

As noted prior, the FGS geo-marker did not provide multiple benefits as a qualitative aspect of the data collection during the SQ, only the OGS geo-marker. As such, 8.6% of OGS markers provided the full range of HWB benefits – Physical, Social and Psychological within both CAs. These GS are considered the 'big-hitters' and require further analysis and discussion.

Multi-Affordance PPUIGS

Paisley CA

Barshaw Park,	n=3
GS near Foxbar Rd	n=2
Rouken Glen	n=2

n=1 Rosshall Park
GS near Morrisons and Black Cart Water (Linwood)
GS near Foxbar Rd.
Barshaw Park
Rouken Glen

Vantaa CA

Lammassaari Island	n=10
Meri-Rastila GS	n=3
Vartiosaari Island GS	n=3
GS along Vantaa River	n=2

n=1 Kaivopuisto Park



Figure 9.64
Multi-Affordance PPUIGS Frequencies

Paisley CA Non Structural Factors

Individuals within the region are generalised as travelling long distances, often over 2km, by car, to interact with these publicly owned, Park typologied, named GS but not requiring a special landscape designation to them. Additionally, these results also indicate that individuals do require facilities or amenities and paved paths with only a moderate level of cleanliness and maintenance in the PPUIGS they interact with to achieve multiple HWB benefits.

Vantaa CA Non Structural Factors

Individuals within the region are generalised as travelling long distances, often over 2km, by walking or bike, to interact with these publicly owned, natural and wild GS with a special landscape designation to them. Additionally, these results also indicate that individuals do not require many facilities or amenities, nor a high level of cleanliness and maintenance, and don't require paved paths in the PPUIGS they interact with to achieve multiple HWB benefits.

Paisley CA Structural Factors

Within the Paisley PUR, multi-beneficial HWB PPUIGS are, generally, simple and regular in shape with 3-4 sides and are considered one in a group of many nearby or connected GS that contain mostly grass or low shrubs and clustered and clumped trees so as to feel semi-natural or somewhat wild, with many long views within them. These GS are most often close to a major motorway or heavily trafficked road, with exposed spaces that offer many places for social interaction, both formal and informal, as well as many benches and seating areas, some lights

and some open edges with adequate internal visibility, and perhaps a playground or communal area that can accommodate large groups. Park assemblages in the Paisley PUR are very important multi-beneficial PPUIGS where respondents were able to receive the full suite of HWB benefits. Results show these multi-functional parks were most often associated with interactions with Pollock Park and Barshaw Park

As shown in the following Figures, the GS of the Paisley CA most frequently visited for multiple affordances, and, also most frequently visited, were Pollock Park and Barshaw Park and included the following characterstics and levels:

- Simple Shape;
- GS is considered part of another GS or larger group of GS;
- Uniform Horizontal Vegetation;
- Clustered Vertical Vegetation;
- Semi-Natural Level of Greeness and Vegetation Composition;
- Extensive Visibility with Many Long Views;
- Close or Adjacent to Heavily Trafficked Roads;
- High Sociability;
- Somewhat Safe.

These GS were simple in shape meaning these GS had 3-4 sides and were often uniform or regularly shaped such as squares and rectangles with 90 degree angles to their edges or corners; (See Figure 9.65).



Figure 9.65
Multi-Beneficial GS Characteristics – Simple Shape
(Paisley, Scotland – Barshaw Park)

These GS were considered one in a group of a many nearby GS or physically connected to another GS when viewed without land ownership boundaries (See Figure 9.66).



Figure 9.66
Multi-Beneficial GS Characteristics – Proximity and Connectivity
(Paisley, Scotland – Pollock Park)

These GS included the horizontal vegetation structure characteristic that was considered uniform – meaning whether deciduous and/or coniferous vegetation types, and all under 4’ height, the GS had hardly any different horizontal vegetation types (e.g. play fields, mown grass, small shrubs), and this structure does not include diverse and random vegetation types nor clustered placements) (See Figure 9.67).



Figure 9.67
Multi-Beneficial GS Characteristics – Uniform Horizontal Vegetation
(Paisley, Scotland – Barshaw Park)

These GS included the vertical vegetation structure characteristic that was considered clustered – meaning whether deciduous and/or coniferous vegetation types, and all over 4’ height, the GS had a few or many different vertical vegetation types or species, but not present in all areas of green structure. In these GS, the vertical vegetation is distributed only in clumps or massed areas and is not uniform in distribution such a in allees or lining walkways only, and the vertical vegetation is not considered diverse and random in distribution throughout the GS (See Figure 9.68).



Figure 9.68
Multi-Beneficial GS Characteristics – Clustered Vertical Vegetation
(Paisley, Scotland – Pollock Park)

These GS included the Level of Greeness characteristic and Vegetation Composition and Setting level that was considered semi-natural – meaning, regardless of facilities or amenities including paths, lights, bins, benches, centres, toilets, overall, the GS has a natural feeling to it and a few informal recreation opportunities (beyond trail walking, wildlife viewing, etc) with a variety of vegetation types or limited types of habitats and with some natural or naturalistic vegetation or areas and some manicured grassed areas and some wild or informal planting areas. Agricultural Fields and Grazing Lands are often considered of this Setting. Comparatively, these GS were not considered Natural with no informal recreation opportunities or social activities with a wild feeling to the informal GS structure; nor were these GS considered urban or semi-urban with many manicured, grassed areas and formal structured activities to it such as playing fields and sitting areas or plazas (See Figure 9.69).



Figure 9.69
Multi-Beneficial GS Characteristics – Semi-Natural Vegetation Setting
(Paisley, Scotland – Barshaw Park)

These GS included the Level of Greeness characteristic and Vegetation Structure and Visibility level that was considered Extensive – meaning that within the GS there were many (3+) long and expansive views, within the GS and/or out from the GS. These GS did not provide for moderate or limited visibility either within or out from/into the GS (See Figure 9.70).



Figure 9.70
Multi-Beneficial GS Characteristics – Expansive Visibility
(Paisley, Scotland – Barshaw Park)

These GS are most often near to or directly adjacent to a heavily trafficked road such as an M-Road, A-Road or 4-lane Road (See Figure 9.71).



Figure 9.71
Multi-Beneficial GS Characteristics – Close Proximity to Road
(Paisley, Scotland – Pollock Park)

These GS included the Maintenance and Management characteristic and Facilities and Sociability level that was considered High – meaning that the GS has exposed spaces with many places for social interaction, both formal & informal. There is a designated dog space; many benches and seating areas, and often a playground or communal area. These GS can accommodate large groups. Comparatively, these GS do not contain many or any solitary and isolated spaces (See Figure 9.72).



Figure 9.72
Multi-Beneficial GS Characteristics – High Sociability
(Paisley, Scotland – Barshaw Park)

These GS included the Safety and Security characteristic level that was considered Somewhat Safe – meaning that the GS are considered somewhat safe – not unsafe yet not safe. These GS do have the presence of lighting, locked gates, open edges, visibility/eyes-on, and even management; however, some edges are open and visibility is only acceptable at some places. There may be a few areas with minimal lights and areas with enclosed or dark edges which inhibit visibility (See Figure 9.73).





Figure 9.73
Multi-Beneficial GS Characteristics – Somewhat Safe
(Paisley, Scotland – Barshaw Park)

Vantaa CA Structural Factors

Within the Vantaa PUR, multi-beneficial HWB PPUIGS are, generally, large and extensive in size that separates views to other built structures when within them; typically contain mostly grass or low shrubs; and are most often close to a major motorway or heavily trafficked road. Woodland assemblages in the Vantaa PUR are very important multi-beneficial PPUIGS where respondents were able to receive the full suite of HWB benefits. Results show that these multi-functional woodlands were most often associated with interactions with Paloheina Woodlands and the Fastholma Green Space.

As shown in the following Figures, the GS of the Vantaa CA most frequently visited for multiple affordances, and, also most frequently visited, were Paloheina Woodlands and Fastholma Green Space and included the following characterstics and levels:

- Large Size;
- Uniform Horizontal Vegetation;
- Close or Adjacent to Heavily Trafficked Roads.

These GS were Extensive or Large in Area or Size meaning these GS separated houses well, where one could not see other houses within the GS or at the GS edges looking ourward (See Figure 9.74).

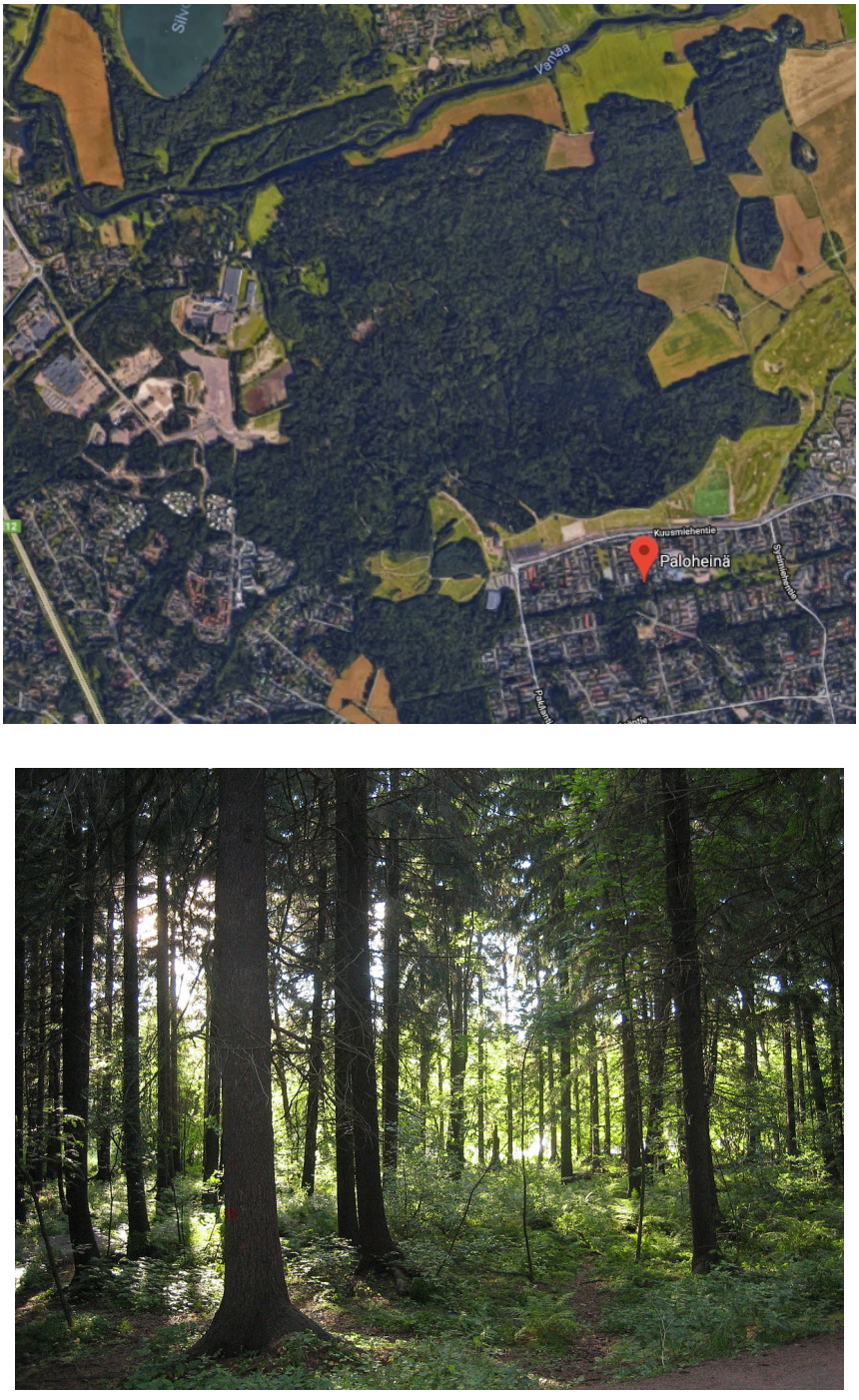


Figure 9.74
Multi-Beneficial GS Characteristics – Extensive Size
(Vantaa, Finland – Paloheina Woodlands)

These GS included the horizontal vegetation structure characteristic that was considered uniform – meaning whether deciduous and/or coniferous vegetation types, and all under 4’ height, the GS had hardly any different horizontal vegetation types or species (e.g. wetlands, mown grass, small shrubs), and this structure does not include diverse and random vegetation types nor clustered placements) (See Figure 9.75).



Figure 9.75
Multi-Beneficial GS Characteristics – Uniform Horizontal Vegetation
(Vantaa, Finland – Fastholma Green Space)

These GS are most often near to or directly adjacent to a heavily trafficked road such as an M-Road, A-Road or 4-lane Road (See Figure 9.76).

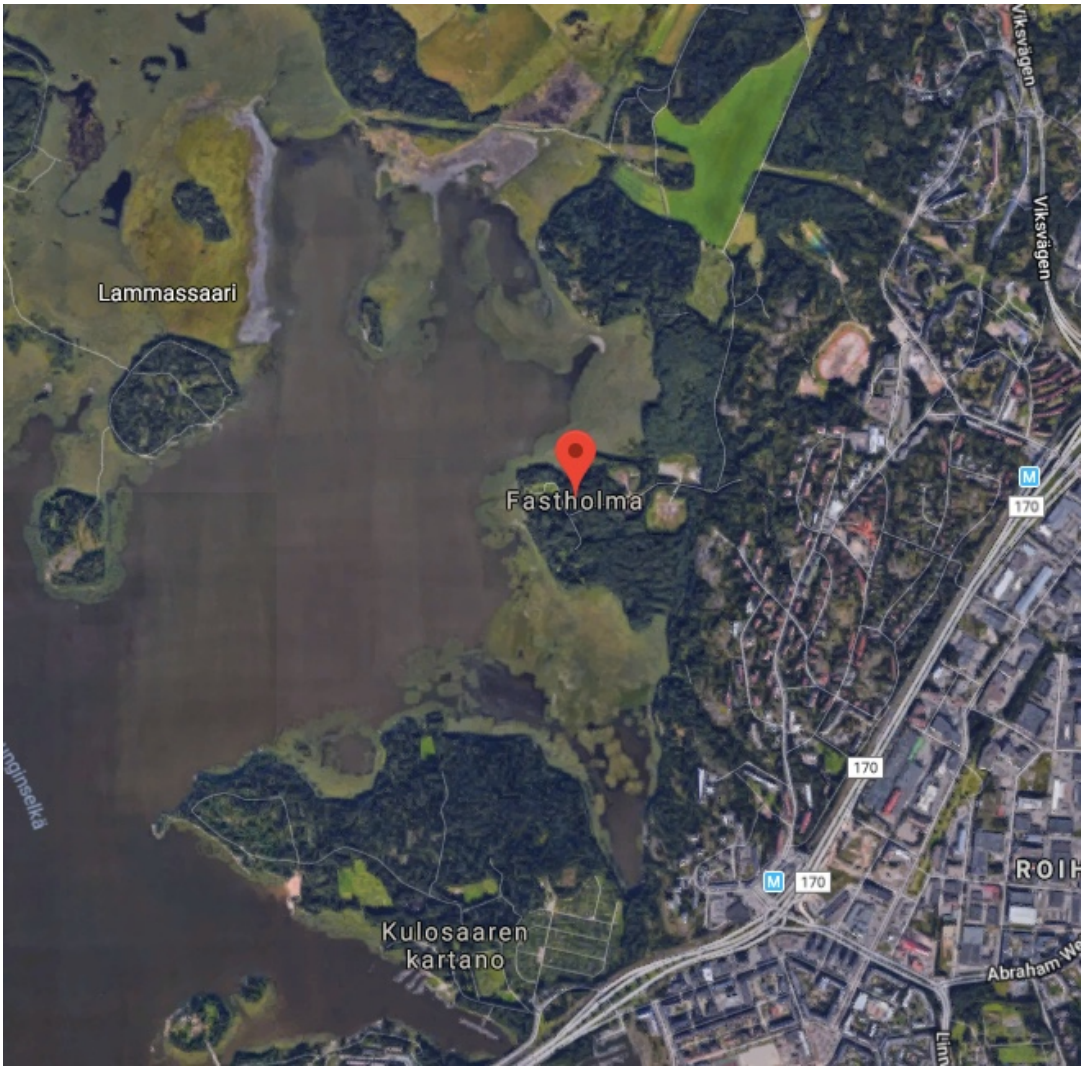


Figure 9.76
Multi-Beneficial GS Characteristics – Close Proximity to Road
(Vantaa, Finland – Fastholma Green Space)

Comparatively, results indicate the eco-spatial characteristics shared between each CA's multi-funcitonal PPUIGS include a larger than average size, a physical integration into the green structure of the overall region, and are most often associated with a publically-owned, far distanced from the home requiring over 2km travel. Contrastingly, whereas Vantaa residents received multiple-affordances from wildlife and naturalistically vegetated and regulated PPUIGS, the Paisley residents interacted with less-natural and semi-urban PPUIGS.

The Vantaa respondents reported a comprehensive set of physical, social and psycholgical benefits such as physical exercise, being with friends and family, and relaxing & enjoying nature due to the PPUIGS having sense of privacy with limited visibility within and into the PPUIGS, with many enclosed and more 'private' spaces due to mixed species, randomly situated vegetation. These Vantaa CA PPUIGS also were only somewhat clean and adequately maintained with very few facilities and amenities such as benches, tables, restrooms and drinking fountains and unpaved paths, whereas the Paisley CA PPUIGS were moderately clean and well maintained with many, abundant facilities and amenities including paved pathways. These results indicate for the Paisley respondents, a cleaner and more well maintained, provisioned PPUIGS adds to one receiving multiple HWB benefits.

9.6 Exploratory Descriptive Analysis Results

This section summarises and describes the results of the SQ data collection, and shows the frequencies, percentages and central tendencies for all single variables (X1, X2, X3 and Y), as well a cross-tabulation descriptive analysis for univariate and bivariate relationships. This analysis also compares the findings between each respondent group in each CA specific to each variable relationship discussed.

A series of relevant cross-tabular analyses were completed to explore relationships within a bivariate analysis. Each statistical analysis provided descriptive statistics such as frequencies and percentages only. No measures of association were made since the prior EFA testing concluded that no statistically

significant relationships exist ($p<0.05$) directly between the variables analysed below.

9.6.1 Relationships to Life Satisfaction

This section describes the demographic and socio-economic information specific to the respondents and their relationship to LS. Pertinent results are summarised below. The relationship examined Life Satisfaction (Y) to the Demographic Data and Socio-Economic variables (X2).

Gender and Life Satisfaction

Paisley CA

Of these 48 respondents, 20 were female (42%) and 28 were male (58%)

Of the 20 female-

15 were Highly Sat or Sat	75%
2 were neither Sat or Unsat	10%
3 were Highly Unsat or Unsat	15%

Of the 28 male-

22 were Highly Sat or Sat	78.6%
2 were neither Sat or Unsat	7.1%
4 were Highly Unsat or Unsat	14.3%

Of the 48 both female and male-

37 were Highly Sat or Sat	77.0%
4 were neither Sat or Unsat	8.3%
7 were Highly Unsat or Unsat	14.6%

Vantaa CA

Of these 52 respondents, 24 were female (46%) and 28 were male (54%)

Of the 24 female-

21 were Highly Sat or Sat	87.5%
2 were neither Sat or Unsat	8.3%
1 were Highly Unsat or Unsat	4.2%

Of the 28 male-

19 were Highly Sat or Sat	67.9%
7 were neither Sat or Unsat	25.0%
2 were Highly Unsat or Unsat	7.1%

Of the 52 both female and male-

40 were Highly Sat or Sat	76.9%

9 were neither Sat or Unsat	17.3%
3 were Highly Unsat or Unsat	5.8%

Figure 9.77
Life Satisfaction and Gender

Overall, percentage-wise, males and females reported similar LS results within the Paisley CA, however, males reported more noticeable less life satisfaction than females in the Vantaa CA.

Age and Life Satisfaction

Paisley CA

Of the 18-24	
1 were Highly Sat or Sat	100%
0 were neither Sat or Unsat	
0 were Highly Unsat or Unsat	
Of the 25-34	
4 were Highly Sat or Sat	57.1%
2 were neither Sat or Unsat	28.6%
1 were Highly Unsat or Unsat	14.3
Of the 35-44	
4 were Highly Sat or Sat	80%
0 were neither Sat or Unsat	
1 were Highly Unsat or Unsat	20%
Of the 45-54	
16 were Highly Sat or Sat	80%
0 were neither Sat or Unsat	
4 were Highly Unsat or Unsat	20%
Of the 55-64	
8 were Highly Sat or Sat	80%
1 were neither Sat or Unsat	10%
1 were Highly Unsat or Unsat	10%
Of the 65-75	
4 were Highly Sat or Sat	80%
1 were neither Sat or Unsat	20%
0 were Highly Unsat or Unsat	

Vantaa CA

Of these 52 respondents, there were various age groups

Of the 18-24	
6 were Highly Sat or Sat	75%
2 were neither Sat or Unsat	25%

	0 were Highly Unsat or Unsat	
Of the 25-34		
	11 were Highly Sat or Sat	91.7%
	1 were neither Sat or Unsat	8.3%
	0 were Highly Unsat or Unsat	
Of the 35-44		
	6 were Highly Sat or Sat	42.9%
	6 were neither Sat or Unsat	42.9%
	2 were Highly Unsat or Unsat	14.3%
Of the 45-54		
	11 were Highly Sat or Sat	100%
	0 were neither Sat or Unsat	
	0 were Highly Unsat or Unsat	
Of the 55-64		
	5 were Highly Sat or Sat	83.3%
	0 were neither Sat or Unsat	
	1 were Highly Unsat or Unsat	16.7%
Of the 65-75		
	1 were Highly Sat or Sat	100%
	0 were neither Sat or Unsat	
	0 were Highly Unsat or Unsat	

Figure 9.78
Life Satisfaction and Age

Within th Paisley CA, 80% of the 35-75 age groups reported Highly Satisfied and Satisfied (HighS or S) LS whereas the 14.3% of the 25-34 age group reported Highly Unsatisfied or Unsatisfied (HighlyU or U) LS as well as 28.6% neither Satisfied nor Unsatisfied (S nor U). Only 57.1% of this age group reported a HighlyS or S LS.

Within the Vantaa CA, 91.7% of the 25-34 age group reported HighlyS or S LS, whereas 14.3% of the 35-44 age group reported a HighlyU or U LS as well as 42.9% who were neither S nor U. Only 42.9% of this age group reported a HighlyS or S LS.

The age group with the highest percentage of LS	
Paisley CA	
(Highly Sat or Sat)	45-54 yr olds
(Neither Highly Sat or Sat)	25-34 yr olds
(Highly Unsat or UnsSat)	45-54 yr olds
Vantaa CA	
(Highly Sat or Sat)	25-34 yr olds
(Neither Highly Sat or Sat)	35-44 yr olds
(Highly Unsat or UnsSat)	35-44 yr olds

Figure 9.79
Life Satisfaction and Age – Highest Percentages
MINIMUM 3 entries to qualify for analysis

Appendix 16 presents and summarises the results for the socio-economic variables.

9.6.1.1 Life Satisfaction Relationships to GS Visitation and Affordances

Regardless of LS ranking, respondents indicated similar GS typologies for interaction - Parks and Gardens and Amenity Green Spaces for Paisley CA and Woodland, Grasslands Ag Lands GS for Vantaa GS (See Figure 9.80).

VeryS or S Vantaa respondents indicated Lamassari Island predominately (12%) whereas Pollock Park (10%) was noted most often for Paisley respondents. The Vantaa CA respondents indicated 10 different GS locations for the VeryU or U LS rankings whereas the Paisley CA U or VeryU LS ranking resondents indicated Barshaw Park in 17% (See Figure 9.81 and 9.82).

PPUIGS Typology Interaction and Life Satisfaction	
Paisley CA	
139 respondents = S or VeryS LS	(n=83)
60% Parks, Gardens & Amenity GS	
Vantaa CA	
170 respondents = S or VeryS LS	(n=69)
41% Woodland, Grasslands Ag GS	
Paisley CA	
23 respondents = U or VeryU LS	(n=12)
52% Parks, Gardens & Amenity GS	
Vantaa CA	
10 respondents = U or VeryU LS	(n=4)
40% Woodland, Grasslands Ag GS	

Figure 9.80
Life Satisfaction and PPUIGS Typology Interaction Comparison

LIFE SATISFACTION * Green Space Typological Definition Crosstabulation

Count

		Green Space Typological Definition						Total
		Parks and Gardens and Amenity Spaces	Woodlands and Grasslands and Agricultural	Other Natural or Semi-Natural GS	Outdoor Sports Facilities & Children's Play Area	Green Corridor	Other Including Cemeteries and Churchyards, Civic Spaces, Wa	
LIFE SATISFACTION	Satisfied & Very Satisfied	83	11	11	13	9	12	139
	Neither Satisfied or Unsatisfied	3	1	1	0	1	1	7
	Unsatisfied & Very Unsatisfied	12	4	1	3	1	2	23
Total		98	16	13	16	11	15	169

LIFE SATISFACTION * Green Space Typological Definition Crosstabulation

Count

		Green Space Typological Definition							Total
		Parks and Gardens and Amenity Spaces	Woodlands and Grasslands and Agricultural	Other Natural or Semi-Natural GS	Outdoor Sports Facilities & Children's Play Area	Green Corridor	Community Gardens, Allotments and City Farms	Other Including Cemeteries and Churchyards, Civic Spaces, Wa	
LIFE SATISFACTION	Satisfied & Very Satisfied	35	69	21	5	22	5	13	170
	Neither Satisfied or Unsatisfied	4	19	7	2	5	0	1	38
	Unsatisfied & Very Unsatisfied	3	4	1	0	0	0	2	10
Total		42	92	29	7	27	5	16	218

Figure 9.81
Life Satisfaction and PPUIGS Typology Interaction
Paisley CA (LEFT) Vantaa CA (RIGHT)

Unsatisfied and Very Unsatisfied Life Satisfaction Ranking and PPUIGS Interaction

Paisley CA

n=23

4 markers

BARSHAW PARK

2 markers

ROUKEN GLEN PARK

1 marker

DAMS TO DARNLEY COUNTY PARK - RESERVOIRS
DAMS TO DARNLEY COUNTY PARK - WAULKMILL GLEN
DAMS TO DARNLEY COUNTY PARK - OPEN FIELDS
CLYDE MURISHIEL REGIONAL PARK - BARR LOCH
CLYDE MURISHIEL REGIONAL PARK - CASTLE SEMPLE LOCH
GLENNIFER BRAES COUNTRY PARK
LINWOODMOSS WOOD
FOUNTAIN GARDENS PARK
POLLOCK PARK
ST JAMES PLAYING FIELDS
BRODIE PARK
BELLAHOUSTON PARK
GS NEAR COWAN PARK
ROSSHALL PARK
SEEDHILL PLAYING FIELDS
GS NEAR LEVERN WATER
GS NEAR WHITE CART WATER

Vantaa CA

n=10 (1 geomarker each)

Central Park – Laakso & Ruskeasuo Section
Lammassaari Island
Meri-Rastala GS
Vartiosaari Island GS
Ramsinranta Peninsula GS
Kallahti Beach
Uutela Recreation Area
Beach as Crussel Bridge
GS Corridor near Lammassaari Island
Kartanonhaka Park
Malminkartano Hill

Figure 9.82
Unsatisfied and Very Unsatisfied Life Satisfaction and PPUIGS Name Interaction Comparison

As shown in Figure 9.83, within the Paisley CA, respondents with a VeryU or U LS ranking (n=23) mostly visited Parks, Gardens, Amenity GS (n=12) for physical HWB benefits (n=1), social HWB benefits (n=5) and psychological HWB benefits (n=6). Vantaa CA respondents similarly (n=10) mostly visited Woodland, Grasslands Ag GS (n=4) for physical HWB benefits (n=1), social HWB benefits (n=2) and psychological HWB benefits (n=1). These results echo the frequency analyses.

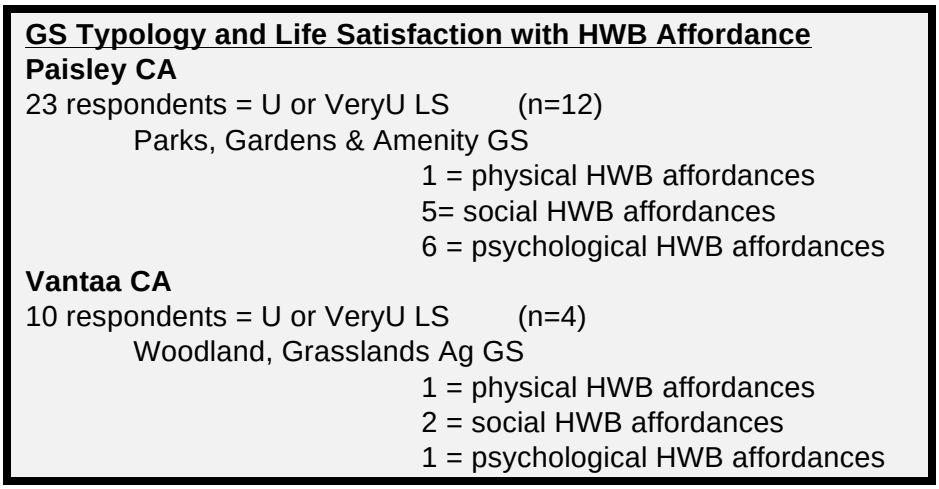
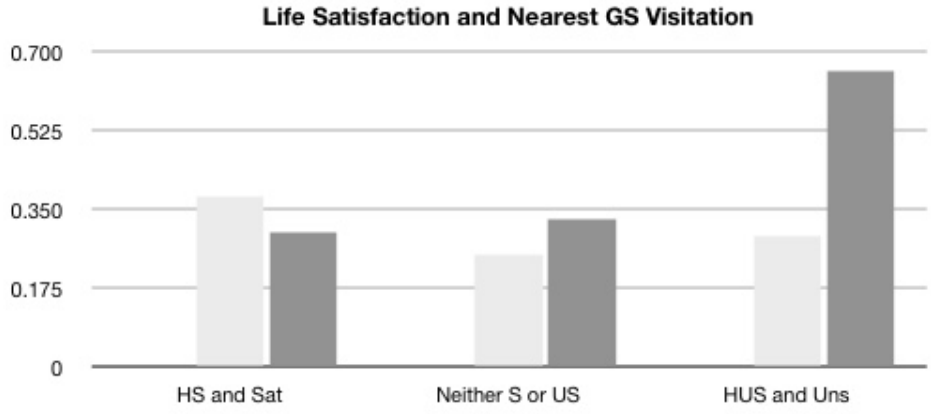


Figure 9.83
Life Satisfaction Levels and GS Typology Interaction for HWB Affordances

9.6.1.2 Life Satisfaction Relationships to Nearest GS Visitation

This section reports the results of particular variables specific to the respondent's visitation of their nearest GS (NGS).



	HS and Sat	Neither S or US	HUS and Uns
Paisley, Scotland CA	38%	25%	29%
Vantaa, Finland CA	30%	33%	66%

Life Satisfaction and NGS Visitation

Paisley: n=48

HS and Sat = 37, 14 visited NGS	38%
Neither S or US = 4, 1 visited NGS	25%
HU and Uns = 7, 2 visited NGS	29%

Vantaa: n= 52

HS and Sat = 40, 12 visited NGS	30%
Neither S or US = 9, 3 visited NGS	33%
HU and Uns = 3, 2 visited NGS	66%

Figure 9.84
Life Satisfaction Nearest GS Visitation

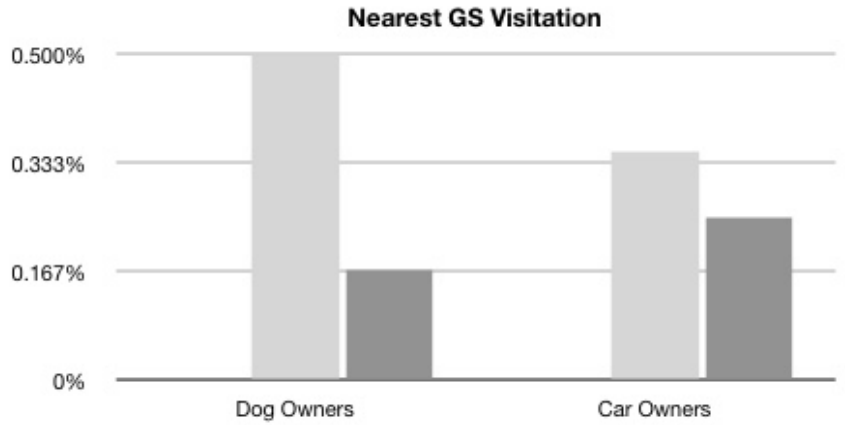
Results show, interestingly, nearly 2/3 of Highly Unsatisfied and Unsatisfied Life Satisfaction respondents within the Vantaa CA visited their nearest GS.

Dog Ownership and NGS Visitation

10 people Paisley own dogs, 5 visited nearest GS (50%)
6 people Vantaa own dogs, 1 visited nearest GS (17%)

Car Ownership and NGS Visitation

49 people Paisley own cars, 17 visited nearest GS (35%)
28 people Vantaa own cars, 7 visited nearest GS (25%)



	Dog Owners	Car Owners
Paisley, Scotland CA	50%	35%
Vantaa, Finland CA	17%	25%

Figure 9.85
Dog Ownership & Car Ownership and Nearest GS Visitation

9.7 Multivariate Analysis Mediation and Moderation Results

The statistical results for the tests are summarised below and reported in detail in Appendix 26. The statistical analysis for mediation utilised the Pearson Correlation Test for both CAs as a test for an indirect effect. There is no correlation (<0.05) between X2 and Y. This analysis therefore determined that the socio-economic and demographic factors (X2) of the respondents do not affect their self-reported life-satisfaction (Y).

The statistical analysis for moderation utilised the Pearson Correlation Test

for both CAs as a test for an indirect effect. There is no correlation (<0.05) between X1 and Y. This analysis therefore determined that the characteristics of the green spaces and green structures (structural and non-structural) the respondents interact with (X1) do not affect their self-reported life-satisfaction (Y).

It was determined that no further modifications (i.e. model fitting) would occur within these two analyses as determined by the results from the factor analysis but that regression analysis would be attempted in subsequent testing methodologies in order to test for significant relationshps between specific variables, particularly the PPUIGS characteristics and HWB affordances.

9.7.1 Testing for Significant Relationships

The statistical analysis for variable influence within this research expresses the relationship as follows:

> Which are the types and what are the eco-spatial characteristics and attribute levels of polycentric spatially fragmented interstitial green structures (X1) that are conducive to particular human well-being benefits (X3) (e.g. psychological, social and/or physical wellbeing)?

Utilising the Cochran-Armitage Trend Test (CATT) and its two-Sided P-Test for both samples (CA), there was statistical significance (<0.05) between X1 and X3 for only a few characteristics of PPUIGS. Additionally, regardless of the characteristic's statistical significance, this analysis also determined that certain and specific characteristic attribute levels (X1) found within the identified PPUIGS tend to be associated with a higher probability of receiving particular HWB benefits (X3), thus indicating a statistical trend of association.

The Cochran-Armitage Trend Test (CATT) was operationalised to analyse the relationship between these variables. CATT is based upon a linear regression model (e.g. chi-2) but is not a regression test. Since this research's data is ordinal (vs. Pearson's r ordinal) [30], CATT is a single-variable analytical technique that

[30] For example, the eco-spatial characteristic of SIZE was given the categorical and ordered values of "Extensive", "Moderate", and "Limited". CATT treats "Extensive", "Moderate", "Limited" as three ordered categories. Alternatively, as per coding values (per SPSS), Pearson correlation assumes "Extensive" = 1, "Moderate" = 2, "Limited" = 3, so those are numeric values, the

looks at one variable at a time and tests for no-association (i.e. null-hypothesis). The strength of association between each PPUIGS characteristic's fragmentation levels and the type of affordance/HWB benefit activity and its eco-spatial characteristics was estimated from CATT's logistic regression model, which adjusted for the categorical values of the PPUIGS characteristics.

The CATT for this question looked at a single independent variable of HWB benefit (X3) (coded as 1= Yes Received, 0=No Received) for each of the physical, social or psychological benefits, or affordances, received, in terms of whether it was influenced by the independent variable of the specific landscape fragmentation characteristic and level (X1) of the geo-marked PPUIGS. The CATT was operated for each of the three HWB benefit variables (physical, social and psychological) separately through the ONE SIDED and TWO SIDED Exact Test, with the resultant output p-values, attribute level percentages and other statistics. Results are included below in Table 9.6 and Table 9.7.

"distance" or "difference" between ("Extensive" = 1 and "Moderate" = 2) is the same as that between ("Moderate" = 2 and "Limited" = 3).

ECO-SPATIAL CHARACTERISTIC and ATTRIBUTE	HWB BENEFIT	LEVEL	Marker %	Pr >= Z	Trend	Trend Level
	(Affordance)			2-sided (<.05)	Y or N	
Size – Area	PHYSICAL	Extensive	70.80%		N	
	SOCIAL	Extensive	75.00%	0.095	Y	Extensive
	PSYCHOLOGICAL	Extensive	70.80%		Y	Limited
Size – Density	PHYSICAL	High	62.90%		Y	Low
	SOCIAL	High	70.40%		Y	High
	PSYCHOLOGICAL	High	77.90%	0.001	Y	High
Size – Largest	PHYSICAL	Moderate	55.70%	0.097	N	
	SOCIAL	Moderate	50.00%		Y	Largest
	PSYCHOLOGICAL	Moderate	58.40%		N	
Shape - Regualtion	PHYSICAL	Irregular	48.40%		N	
	SOCIAL	Regular	45.10%		N	
	PSYCHOLOGICAL	Regular	45.70%		N	
Shape - Regualtion	PHYSICAL	Urban	42.90%		N	
Greeness	SOCIAL	Natural	37.00%		N	
	PSYCHOLOGICAL	Natural	42.60%		Y	Natural
Shape - Complexity and Diversity	PHYSICAL	Simple	47.60%		Y	Simple
	SOCIAL	Simple	44.20%		N	
	PSYCHOLOGICAL	Simple	44.10%		N	
Proximity - Nearest GS Neighbour	PHYSICAL	Connected	66.20%		Y	Separted
	SOCIAL	Connected	68.50%		N	
	PSYCHOLOGICAL	Connected	80.00%	0.001	Y	Connected
Proximity - Isolation and Connectivity	PHYSICAL	Grouped	53.60%		N	
	SOCIAL	Grouped	59.30%		N	
	PSYCHOLOGICAL	Grouped	63.80%	0.050	Y	Grouped
Proximity - Level of Coherence	PHYSICAL	Autonomous	54.40%	0.087	Y	Linear
	SOCIAL	Autonomous	55.80%		N	
	PSYCHOLOGICAL	Integrated	61.20%	0.001	N	Integrated
Edge - Total Edge	PHYSICAL	Numerous	36.40%		Y	Few
	SOCIAL	Moderate	41.70%		N	
	PSYCHOLOGICAL	Moderate	37.00%		Y	Few
Edge - Longest Edge	PHYSICAL	Moderate	81.40%		N	
	SOCIAL	Moderate	68.10%		Y	Longest
	PSYCHOLOGICAL	Moderate	66.30%		N	

Edge - Edge Density	PHYSICAL	Moderate	45.70%		N	
	SOCIAL	Dense	39.60%	0.021	Y	Dense
	PSYCHOLOGICAL	Transparent	37.20%		N	
Level of Green - Veg. Composition	PHYSICAL	Deciduous	48.60%		N	
	SOCIAL	Mixed	44.40%		N	
	PSYCHOLOGICAL	Deciduous	53.70%		Y	Deciduous
Level of Green - Veg. Composition	PHYSICAL	Semi-Natura	40.80%		N	
Setting	SOCIAL	Semi-Natura	51.90%		N	
	PSYCHOLOGICAL	Semi-Natura	50.50%		N	
Level of Green - Vegetation Structure	PHYSICAL	Uniform	60.60%	0.074	N	
Horizontal	SOCIAL	Uniform	44.40%		N	
	PSYCHOLOGICAL	Uniform	48.90%		N	
Level of Green - Vegetation Structure	PHYSICAL	Clustered	40.80%		N	
Vertical	SOCIAL	Clustered	61.10%		N	
	PSYCHOLOGICAL	Clustered	44.70%		N	
Level of Green - Vegetation Structure	PHYSICAL	Open	54.30%	0.017	N	
Density	SOCIAL	Dense	45.30%		N	
	PSYCHOLOGICAL	Open	36.60%		N	
Level of Green	PHYSICAL	Close	42.30%		N	
Proximity to Heavy Traffic Road	SOCIAL	Close	61.10%		N	
	PSYCHOLOGICAL	Close	46.30%		N	
Level of Green - Vegetation Structure	PHYSICAL	Extensive	49.30%		N	
Visibility	SOCIAL	Extensive	46.30%		N	
	PSYCHOLOGICAL	Extensive	52.60%		Y	Extensive
Maintenance and Management	PHYSICAL	Moderate	56.30%	0.018	N	
Cleanliness	SOCIAL	Clean	59.30%		N	
	PSYCHOLOGICAL	Clean	50.50%		N	
Maintenance and Management	PHYSICAL	Abundant	38.00%		Y	Inadequate
Facilities	SOCIAL	Abundant	48.10%		N	
	PSYCHOLOGICAL	Abundant	40.00%		N	
Maintenance and Management	PHYSICAL	Paved	47.90%		N	
Facilities - Paths	SOCIAL	Paved	41.50%		N	
	PSYCHOLOGICAL	Mixed	37.90%		N	

Maintenance and Management	PHYSICAL	High	62.30%		N	
Facilities - Sociability	SOCIAL	High	50.00%		N	
	PSYCHOLOGICAL	High	58.90%		N	
Safety and Security	PHYSICAL	Somewhat	50.70%		N	
	SOCIAL	Somewhat	63.00%		N	
	PSYCHOLOGICAL	Somewhat	58.90%		N	

Table 9.6
Cochran-Armitage Trend Test Results
Paisley CA

ECO-SPATIAL CHARACTERISTIC and ATTRIBUTE	HWB BENEFIT	LEVEL	Marker %	Pr >= Z	Trend	Trend Level
				2-sided (<.05)	Y or N	
Size – Area	PHYSICAL	Extensive	66.40%		N	
	SOCIAL	Extensive	51.60%		N	
	PSYCHOLOGICAL	Extensive	62.50%		Y	Extensive
Size – Density	PHYSICAL	High	48.40%		N	
	SOCIAL	Moderate	47.20%		N	
	PSYCHOLOGICAL	Moderate	52.70%		N	
Size – Largest	PHYSICAL	Largest	38.90%		N	
	SOCIAL	Moderate	45.20%	0.018	Y	Small
	PSYCHOLOGICAL	Moderate	47.10%		N	
Shape - Regualtion	PHYSICAL	Irregular	39.60%		N	
	SOCIAL	Regular	38.70%		Y	Regular
	PSYCHOLOGICAL	Irregular	45.20%		N	
Shape - Regualtion	PHYSICAL	Natural	57.70%		Y	Urban
Greeness	SOCIAL	Natural	53.20%		N	
	PSYCHOLOGICAL	Natural	68.30%	0.035	Y	Natural
Shape - Complexity and Diversity	PHYSICAL	Moderate	36.20%		N	
	SOCIAL	Moderate	41.90%		N	
	PSYCHOLOGICAL	Moderate	35.60%		Y	Complex
Proximity - Nearest GS Neighbour	PHYSICAL	Connected	83.90%		N	
	SOCIAL	Connected	74.20%	0.014	Y	Separated
	PSYCHOLOGICAL	Connected	80.80%		N	
Proximity - Isolation and Connectivity	PHYSICAL	Grouped	77.00%		N	
	SOCIAL	Grouped	66.10%	0.007	Y	Isolated
	PSYCHOLOGICAL	Grouped	78.60%		N	
Proximity - Level of Coherence	PHYSICAL	Integrated	71.10%	0.003	Y	Linear
	SOCIAL	Integrated	82.30%		N	
	PSYCHOLOGICAL	Integrated	78.80%		Y	Integrated
Edge - Total Edge	PHYSICAL	Moderate	36.20%		N	
	SOCIAL	Moderate	37.10%		N	
	PSYCHOLOGICAL	Numerous	45.20%		N	
Edge - Longest Edge	PHYSICAL	Moderate	42.20%		N	
	SOCIAL	Least	41.00%	0.004	Y	Least
	PSYCHOLOGICAL	Moderate	42.70%		N	

Edge - Edge Density	PHYSICAL	Dense	42.90%		N	
	SOCIAL	Transparent	39.60%	0.014	N	
	PSYCHOLOGICAL	Dense	45.60%		N	
Level of Green - Veg. Composition	PHYSICAL	Mixed	83.70%		N	
	SOCIAL	Mixed	80.30%		N	
	PSYCHOLOGICAL	Mixed	86.40%		N	
Level of Green - Veg. Composition	PHYSICAL	Natural	46.90%		N	
Setting	SOCIAL	Natural	27.90%	<.0001	Y	Urban
	PSYCHOLOGICAL	Natural	52.40%	0.042	Y	Natural
Level of Green - Vegetation Structure	PHYSICAL	Uniform	47.60%		N	
Horizontal	SOCIAL	Uniform	67.20%	0.001	Y	Uniform
	PSYCHOLOGICAL	Uniform	49.50%		N	
Level of Green - Vegetation Structure	PHYSICAL	Div & Rndom	53.10%	0.078	N	
Vertical	SOCIAL	Clustered	44.30%	0.018	N	
	PSYCHOLOGICAL	Div & Rndom	55.30%		N	
Level of Green - Vegetation Structure	PHYSICAL	Dense	45.60%		Y	Dense
Density	SOCIAL	Open	39.30%	0.006	Y	Open
	PSYCHOLOGICAL	Moderate	28.20%		Y	Dense
Level of Green	PHYSICAL	Close	46.30%		N	
Proximity to Heavy Traffic Road	SOCIAL	Close	45.90%		N	
	PSYCHOLOGICAL	Close	46.60%		Y	Close
Level of Green - Vegetation Structure	PHYSICAL	Limited	43.50%		N	
Visibility	SOCIAL	Moderate	44.30%	0.037	Y	Extensive
	PSYCHOLOGICAL	Limited	48.50%	0.099	Y	Limited
Maintenance and Management	PHYSICAL	Moderate	59.90%		N	
Cleanliness	SOCIAL	Clean	57.40%	0.001	Y	Clean
	PSYCHOLOGICAL	Moderate	62.10%		N	
Maintenance and Management	PHYSICAL	Adequate	49.70%		N	
Facilities	SOCIAL	Adequate	52.50%	0.002	Y	Abundant
	PSYCHOLOGICAL	Adequate	40.80%	0.052	Y	Inadequate
Maintenance and Management	PHYSICAL	Unpaved	55.80%		N	
Facilities - Paths	SOCIAL	Unpaved	45.20%	0.002	Y	Paved
	PSYCHOLOGICAL	Unpaved	66.30%	0.036	N	
Maintenance and Management	PHYSICAL	Mixed	46.90%		N	
Facilities - Sociability	SOCIAL	Mixed	41.90%	0.018	Y	High
	PSYCHOLOGICAL	Mixed	47.10%	0.038	Y	Low
Safety and Security	PHYSICAL	Somewhat	51.70%		N	
	SOCIAL	Safe	51.60%	<.0001	Y	Safe
	PSYCHOLOGICAL	Somewhat	58.70%		Y	Unsafe

Table 9.7
Cochran-Armitage Trend Test Results
Vantaa CA

This analysis first tested for p-values with a two-sided p-value <0.05, signifying statistical significance. If the p-value was >0.05, the null hypothesis was supported, indicating that the specific PPUIGS landscape fragmentation characteristic (e.g. size, shape, proximity, etc.) had no significant influence upon the receipt of HWB benefits through GS interaction.

9.7.2 Two-Sided P-Test Results – Strength of Relationships

This test reported variable association if *both* the one-sided and two-sided Pr (P-value) were <0.05. The two-tailed value provided a more-robust standard deviation (SD) analysis to reject the null-hypothesis. Specifically, if the result fails to reject a hypothesis at the 5% significance level, p >0.05, it also will fail to reject the hypothesis at the 1% significance level. CATT shows that some statistically significant relationships exist between the HWB benefit received and their PPUIGS landscape fragmentation characteristic attributes and levels.

Paisley CA

Overall, only seven of the total of 72 (9.7%) PPUIGS characteristics expressed as variables indicated a statistically significant relationship between them (p<0.05) and HWB benefits. Four of these seven, however, were for psychological-based HWB benefits.

The strongest of these relationships was exhibited between psychological wellbeing benefits and the Proximity–Coherence with the Integrated level to the PPUIGS (p=0.0006). The second strongest relationship occurred between psychological-based wellbeing benefits and the Size–Density characteristic with the High Density level to the PPUIGS (p=0.0010). The third strongest relationship occurred between psychological-based wellbeing benefits and the Proximity–Nearest Neighbour characteristic with the Connected level to another PPUIGS (p=0.0013).

Psychological	Proximity – Coherence (Integrated)	(0.0006)
Psychological	Size – Density (High)	(0.0010)
Psychological	Proximity – NN (Connected)	(0.0013)
Physical	Veg. Structure – Density (Open)	(0.017)
Physical	Maint. & Mgmt. – Cleanliness (Moderate)	(0.018)
Social	Edge - Density (Dense)	(0.021)
Psychological	Proximity – Isol. & Connctvty (Grouped)	(0.050)

Table 9.8
CATT Results with Statistiscal Significance
Paisley CA

Additionally, four characteristics are approaching statistical significance:

Physical	Veg Structure – Horizontal (Uniform)	(0.074)
Physical	Proximity- Level of Coherence (Autonom)	(0.087)
Social	Size – Area (Extensive)	(0.095)
Physical	Size – Largest (Moderate)	(0.097)

Table 9.9
CATT Results Approaching Statistical Significance
Paisley CA

Overall, those HWB affordances with statistically significant PPUIGS characteristic's levels including those approaching predominantly show that a PUL landscape and PPUIGS with unfragmented qualities are more conducive to providing HWB benefits for the Paisley CA respondents.

Vantaa CA

Overall, 20 of the 72 (28%) total PPUIGS variables indicated a statistically significant relationship between them ($p<0.05$) and HWB benefits. 15 of the 20 were for social-based HWB benefits, however, with psychological-based HWB benefits being the next most statistically significant variable (n=4).

The two strongest of these relationships ($p<0.001$) were exhibited between social wellbeing benefits and the Level of Green Composition–Setting with the of Natural and the Safety and Security characteristics with the Safe level for the PPUIGS. The third strongest relationship within the Vantaa CA occurred between social wellbeing benefits and the Maintenance and Management–Cleanliness characteristic with the level of Clean ($p=0.0012$). The fourth strongest relationship occurred between social wellbeing benefits and the Level of Green–Vegetation Structure-Horizontal characteristic with level of Uniform ($p=0.0013$).

Social	Level of Green Comp–Setting (Natural)	(<0.001)
Social	Safety and Security (Safe)	(<0.001)
Social	Maint & Mgmnt-Cleanliness (Clean)	(0.0012)
Social	Level of Green–Veg Str-Horiz (Uniform)	(0.0013)
Social	Maint. & Mgmt. – Facilities (Adequate)	(0.002)
Social	Maint. & Mgmt. – Paths (Unpaved)	(0.002)
Physical	Proximity – Level of Coherence (Integrated)	(0.003)
Social	Longest Edge (Least)	(0.004)
Social	Green – Veg. Strctre. – Density (Open)	(0.006)
Social	Proximity – Isol. & Cnnctvty (Grouped)	(0.007)
Social	Edge Density (Transparent)	(0.014)
Social	Proximity – Nearest Neigh. (Connected)	(0.014)
Social	Green – Veg. Strctre.- Vert. (Clustered)	(0.018)
Social	Size – Largest (Moderate)	(0.018)
Social	Maint. & Mgmt. – Sociability (Mixed)	(0.018)
Psychological	Shape – Regulation Greenness (Natural)	(0.035)
Psychological	Maint. & Mgmt. – Paths (Mixed)	(0.036)
Social	Green – Veg. Strctre. – Visibl. (Moderate)	(0.037)
Psychological	Maint. & Mgmt. – Sociability (Mixed)	(0.038)
Psychological	Green – Compstn. – Setting (Natural)	(0.042)

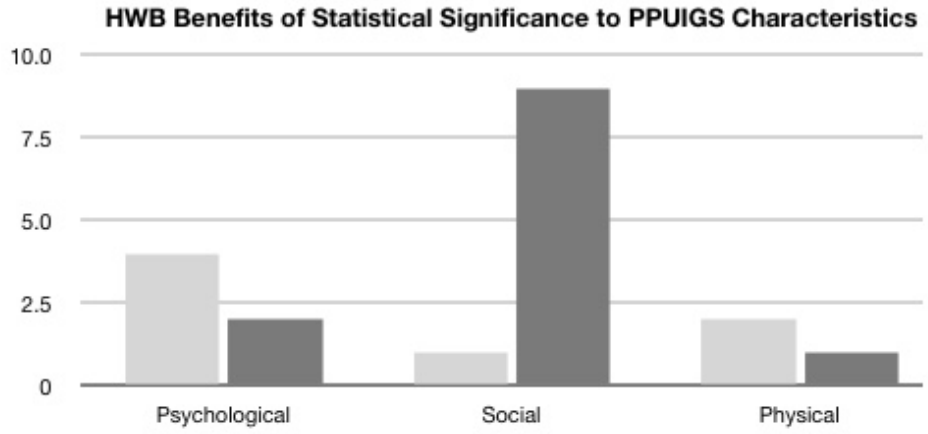
Table 9.10
CATT Results with Statistiscal Significance
Vantaa CA

Additionally, three attribute levels are approaching statistical significance:

Psychological	Maint. & Mgmt. – Facilities (Adequate)	(0.052)
Physical	Veg Structure – Vertical (Dvrse & Rndm)	(0.078)
Psychological	Veg Structure – Visibility (Limited)	(0.099)

Table 9.11
CATT Results Approaching Statistical Significance
Vantaa CA

Overall, those HWB affordances with statistically significant PPUIGS characteristic's levels including those approaching significance, mostly, but not clearly, show that a PUL landscape and PPUIGS with unfragmented qualities are more conducive to providing HWB benefits for the Vantaa CA respondents.



	Psychological HWB	Social HWB	Physical HWB
Paisley, Scotland CA	4	1	2
Vantaa, Finland CA	2	9	1

Figure 9.86
CATT Results - HWB Benefits with Statistical Significance
Case Study Comparison

Comparatively, social-based affordances were reported as statistically significant within the Vantaa CA much more frequently than the Paisley CA.

9.7.3 Attribute Level Percentages Results – Trend of Relationships

This section presents a summary of both the frequency results and the CATT's significance and trend tests. A statistical analysis of the PPUIGS characteristic attribute level frequencies and percentages was completed within the CATT output. This analysis looked for meaningful order within the frequency tables of the attribute results, specifically towards fragmentation or non-fragmentation levels of each PPUIGS characteristic.

This analysis has nothing to do with the strength of the relationship (i.e. statistical significance, as per the previous section) but rather with the potential trend of a relationship existing between the HWB benefit and the specific levels that resulted within the PPUIGS characteristics' attributes of that statistical

variable.

For example, withn the Vantaa CA, the variable of physical HWB benefit and the PPUIGS characteristic and attribute of Shape–Regulation (Greenness), the attribute levels reflect the landscape heterogeneity and human development impact aspects (coded as Natural=1, Moderate=2, Urban=3). Results are as follows:

For Natural=1 the percentage (or "probability") of receiving a Physical HWB benefit = 58%

For Moderate=2 the percentage (or "probability") of receiving a Physical HWB benefit = 64%

For Urban=3 the percentage (or "probability") of receiving a Physical HWB benefit = 67%

Figure 9.87
Trend of Relationship Results Interpretation Example

This result illustrates that there is a tendency that a more *urban* GS shape regulation tends to be associated with a higher probability (67% vs 64% and 58%) of receiving a Physical HWB benefit. This is a valid statement. When one views the p-value result (p=0.1464), however this *relationship* is not statistically significant, meaning it is not likely that Urban PPUIGS Shape Regulation influences the Physical HWB benefit. Nonetheless, it is important to note that a potential trend still exists. Within this research's limited sample size, it is inferred that a larger sample size would result in statistical significance ($p<0.05$) between those PPUIGS attribute levels and associated HWB benefits currently indicating only a potential trend.

The following tables shows only those potential trends for a relationship existing between the PPUIGS characteristic's attribute level and a physical, social, or psychological HWB benefit. Additionally, if this trend is statistically significant ($p<0.05$) or approaching statistical significance (per Tables 9.8 thru 9.11) this is stated. It is important to note the specific attribute level descriptor, in parens, associated with this trend, since some are more spatially heterogeneous and diverse and some are more spatially homogeneous and integrated which are indicative of landscape change or fragmentation within the PPUIGS spatial qualities.

Paisley CA

Physical-based HWB Benefit

Proximity – Level of Coherence (Linear Corridor)	(p=0.087)
Size – Density (Low Density)	
Shape – Complexity and Diversity (Simple)	
Proximity – Nearest Neighbour (Separated)	
Edge – Total Edge (Few)	
Maintenance and Management – Facilities (Inadequate)	

Social-based HWB Benefit

Edge - Edge Density (Dense)	(p=0.021)
Size – Area (Extensive)	(p=0.097)
Size – Density (High Density)	
Size – Largest (Largest)	
Edge - Longest Edge (Longest)	

Psychological-based HWB Benefit

Size – Density (High Density)	(p=0.001)
Proximity - Nearest GS Neighbour (Connected)	(p=0.001)
Size – Area (Limited)	
Shape – Regulation - Greenness (Natural)	
Proximity - Isolation and Connectivity (Grouped)	
Edge - Total Edge (Few)	
Level of Green - Veg. Composition (Deciduous)	
Level of Green – Vegetation Structure – Visibility (Extensive)	

Figure 9.88
CATT Relationhip Trend Results & Noted Significance
Paisley CA

Vantaa CA

Physical-based HWB Benefit

Proximity - Level of Coherence (Integrated)	(p=0.003)
Shape – Regulation - Greenness (Urban)	
Level of Green - Vegetation Structure – Density (Dense)	

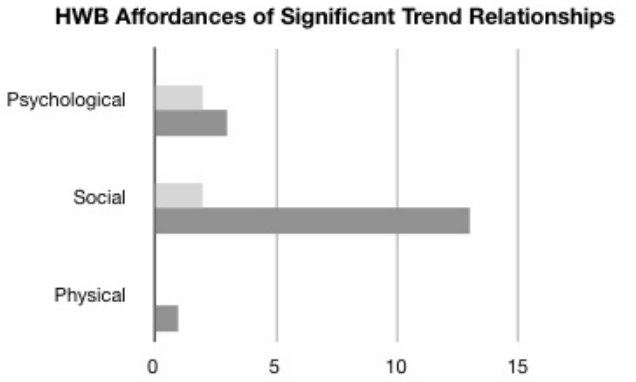
Social-based HWB Benefit

Level of Green - Veg. Composition – Setting (Urban)	(p<0.0001)
Safety and Security (Safe)	(p<0.0001)
Maintenance and Management – Cleanliness (Clean)	(p=0.001)
Level of Green - Vegetation Structure – Horizontal (Uniform)	(p=0.001)
Maintenance and Management – Facilities (Abundant)	(p=0.002)
Maintenance and Management – Facilities - Paths (Paved)	(p=0.002)
Level of Green - Vegetation Structure – Density (Open)	(p=0.006)
Proximity - Isolation and Connectivity (Isolated)	(p=0.007)
Proximity - Nearest GS Neighbour (Separated)	(p=0.014)
Edge - Longest Edge (Least)	(p=0.014)
Maintenance and Management – Facilities – Sociability(High)	(p=0.018)
Size – Largest (Small)	(p=0.018)
Level of Green – Vegetation Structure – Visibility (Extensive)	(p=0.037)
Shape – Regulation (Regular)	

Psychological-based HWB Benefit

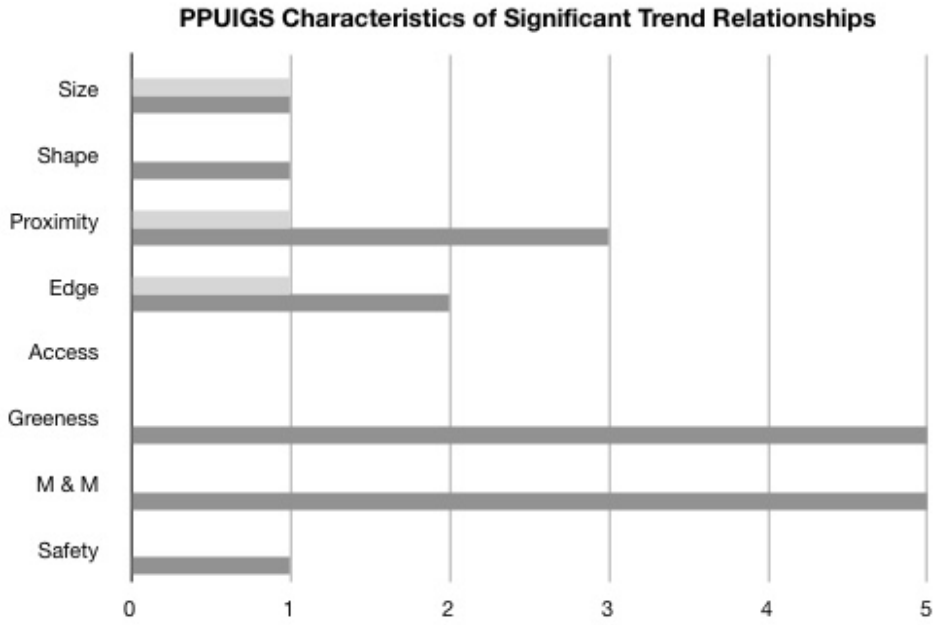
Shape – Regulation - Greenness (Natural)	(p=0.035)
Maintenance and Management – Facilities – Sociability(Low)	(p=0.038)
Level of Green - Veg. Composition – Setting (Natural)	(p=0.042)
Maintenance and Management – Facilities (Inadequate)	(p=0.052)
Level of Green – Vegetation Structure – Visibility (Limited)	(p=0.099)
Size – Area (Extensive)	
Shape – Complexity and Diversity (Complex)	
Proximity - Level of Coherence (Integrated)	
Level of Green - Vegetation Structure – Density (Dense)	
Level of Green – Proximity to Traffic Road (Close)	
Safety and Security (Unsafe)	

Figure 9.89
CATT Relationship Trend Results & Noted Significance
Vantaa CA



	Psychological HWB	Social HWB	Physical HWB
Paisley, Scotland CA	2	2	0
Vantaa, Finland CA	3	13	1

Figure 9.90
HWB Affordances with Significant Relationship Trends to PPUIGS Characteristics



	Size	Shape	Proximity	Edge	Access	Level of Green	Maint & Mgmt	Safety
Paisley, Scotland CA	1	0	1	1	0	0	0	0
Vantaa, Finland CA	1	1	3	2	0	5	5	1

Figure 9.91
PPUIGS Characteristics with Significant Relationship Trends to HWB Affordances

As shown, not all significant PPUIGS characteristics and levels noted within Table 9.8 and 9.10 were also indictive of trends toward certain levels. These trend results provide a more detailed understanding of which PPUIGS characteristics and their specific attribute levels that could potentially impact HWB affordances stronger than others. These trend test results are not stronger nor more valid than the prior CATT statistically significant results in an exploration of relationships, but add to the understanding of each CA's landscape fragmentation and urbanisation trends and potential impacts. All of the characteristics and

attribute levels identified (i.e. withn parens) are potentially significant within a larger sample size (See Figures 9.82 and 9.83).

However, those PPUIGS characteristic level trends which also have statistical significance (per Tables 9.8 and 9.10) are important to note and discuss. These significant characteristics and associated measurement level trends are noted and explained within Tables 9.12 and 9.13. These two results are the important findings of this research.

A brief discussion of these results and their findings will be structured through two distinct yet interrelated formats: First, a discussion of the specific HWB affordances as related to the specific eco-spatial characteristics and attributes within each case study's CA, and second, a discussion of those eco-spatial characteristics within the larger landscape and GS context or PPUIGS assemblages of each CA. Both will focus on landscape fragmentation and spatial heterogeneity aspects found within the PolyPUR.

HWB BENEFIT	PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	SOCIO-ECOLOGICAL PPUIGS ATTRIBUTE LEVELS CATT Trends of Significance
Psychological	**SIZE**	DENSITY	**High Density - green structure is seen nearby** ***Moderate Density*** *- green structure is seen at a distance but not nearby* ***Low Density*** *- green structure is not seen at all*
Psychological	**PROXIMITY**	NEAREST NEIGHBOUR	**Connected - green structure is physically connected to another at least 1 side (no street, wall, fence - path ok)** ***Nearby*** *- one can see another green structure (50m minimum width facing) from most parts of the green structure, but not physically connected. A street, rail or wall/fence may separate the green structure.* ***Separated*** *- green structure is alone & separate, not physically or visually connected, cannot see another green structure from any parts of green structure*
Social	**EDGE**	EDGE DENSITY (Vegetation or Structures)	**Dense - dense edges, not very visible into green structure, blocks views into green structure** ***Moderate*** *- some edge areas offer visibility into green structure* ***Transparent*** *- very open edges, easily visible into green structure from outside-in or inside-out*

Table 9.12
PPUIGS Attribute Levels with Significant Relationship Trends to HWB Affordances Noted in Bold
Paisley CA

HWB BENEFIT	PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	SOCIO-ECOLOGICAL PPUIGS ATTRIBUTE LEVELS CATT Trends of Significance
Social	**SIZE**	LARGEST	*Largest - green structure is very large and is the largest (>75%) in the catchment area* *Moderate - green structure is normal sized when compared to others (in CA)(25%-75%)* **Small - green structure is very small and is the smallest (<25%) in the catchment area**
Psychological	**SHAPE**	LEVEL OF GREENESS	**Natural - green structure feels wild and natural, sense of ruralness to it (e.g. Woodlands)** *Moderate - green structure feels neither natural or urban (e.g. Agricutlural and Grazing lands)* *Urban - green structure feels urban, not very natural or rural at all (e.g. Playing Fields, Civic Plaza, Monument)*
Social	**PROXIMITY**	NEAREST NEIGHBOUR	*Connected - green structure is physically connected to another at least 1 side (no street, wall, fence - path ok)* *Nearby - one can see another green structure (50m minimum width facing) from most parts of the green structure, but not physically connected. A street, rail or wall/fence may separate the green structure.* **Separated - green structure is alone & separate, not physically or visually connected, cannot see another green structure from any parts of green structure**

HWB BENEFIT	PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	SOCIO-ECOLOGICAL PPUIGS ATTRIBUTE LEVELS CATT Trends of Significance
Social	**PROXIMITY**	ISOLATION and CONNECTIVITY	*Grouped - considered 1 in a group of many green structures nearby* *Moderate - considered 1 in a group of few green structures nearby* **Isolated - only green structure, none in nearby group**
Physical	**PROXIMITY**	COHERENCE	*Integrated - green structure is part of bigger, physically and spatially (e.g. garden within housing, village green within neighbourhood, playground within larger park) or area within larger green structure (e.g. Regional or Country Park)* *Autonomous - green structure sits independently - by itself - and is autonomous and not part of a bigger park (e.g. Regional or Country Park)* **Linear Corridor (river walk, bicycle route, etc).**
Social	**EDGE**	LONGEST EDGE (Length)	*Longest - green structure has some or a very long edge, longest in area* *Moderate - green structure has normal edge sizes when compared to others* **Least - green structure has some or a very short edge, shortest in area**

HWB BENEFIT	PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	SOCIO-ECOLOGICAL PPUIGS ATTRIBUTE LEVELS CATT Trends of Significance
Psychological	**GREENESS**	VEGETATION COMPOSITION - SETTING *(May have 1 or more of the following:)*	**Natural - green structure is very natural and has no informal recreation opportunities (beyond trail walking, wildlife viewing, etc), a wide variety of vegetation types and/or types of habitats and with predominately natural or naturalistic vegetation. Green structure lacks a formal composition and may have a 'wild' feeling to it.** *Semi-Natural - green structure still has a natural feeling to it and a few informal recreation opportunities (beyond trail walking, wildlife viewing, etc) with a variety of vegetation types or limited types of habitats and with some natural or naturalistic vegetation or areas. Agricultural Fields and Grazing Lands are often considered of this Setting.* *Semi-Urban - green structure has a few informal and at least one formal recreation area. There is a good mixture of both formal and informal plantings and habitat or vegetation types. Some large, manicured grassed areas.* *Urban - green structure has mostly formal recreation opportunities. Vegetation types may be varied but are managed heavily and/or predominately ornamental vegetation varieties. There may be many formalised, manicured grassed areas. There may be many formal plantings. Play fields are often considered of this Setting.*

HWB BENEFIT	PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	SOCIO-ECOLOGICAL PPUIGS ATTRIBUTE LEVELS CATT Trends of Significance
Social	**GREENESS**	VEGETATION COMPOSITION - SETTING *(May have 1 or more of the following:)*	*Natural - green structure is very natural and has no informal recreation opportunities (beyond trail walking, wildlife viewing, etc), a wide variety of vegetation types and/or types of habitats and with predominately natural or naturalistic vegetation. Green structure lacks a formal composition and may have a 'wild' feeling to it.* *Semi-Natural - green structure still has a natural feeling to it and a few informal recreation opportunities (beyond trail walking, wildlife viewing, etc) with a variety of vegetation types or limited types of habitats and with some natural or naturalistic vegetation or areas. Agricultural Fields and Grazing Lands are often considered of this Setting.* *Semi-Urban - green structure has a few informal and at least one formal recreation area. There is a good mixture of both formal and informal plantings and habitat or vegetation types. Some large, manicured grassed areas.* **Urban - green structure has mostly formal recreation opportunities. Vegetation types may be varied but are managed heavily and/or predominately ornamental vegetation varieties. There may be many formalised, manicured grassed areas. There may be many formal plantings. Play fields are often considered of this Setting.**

HWB BENEFIT	PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	SOCIO-ECOLOGICAL PPUIGS ATTRIBUTE LEVELS CATT Trends of Significance
Social	**GREENESS**	VEGETATION STRUCTURE - HORIZONTAL *(not dependent upon vegetative composition)*	*Diverse and Random - green structure with many different horizontal vegetation types whose diversity is visually dominant. Distribution is many and informal/ wild.* *Clustered - a few or many different horizontal vegetation types, but not present in all areas of green structure. Horizontal vegetation is distributed only in clumps or massed planting areas.* **Uniform - green structure with hardly any or different horizontal vegetation types (e.g. play fields, mown grass parks). Little horizontal vegetation distribution within GS.**
Social	**GREENESS**	VEGETATION STRUCTURE - DENSITY *(not dependent upon vegetative composition)*	*Dense - within green structure, many dense or clustered plantings, crowded and tightly-packed.* *Moderate - within green structure, both dense and sparse areas* **Open - within green structure, sparse plantings, few plantings, spacious (mostly grass areas, play fields).**
Social	**GREENESS**	VEGETATION STRUCTURE - VISIBILITY	**Extensive - within green structure, many (3+) long and expansive views, within green structure and/ or out from green structure** *Moderate - within green structure, a few (1-3) extensive views, some areas with limited visibility* *Limited - within green structure, no long or expansive views either within green structure or out from green structure, limited visibility*

HWB BENEFIT	PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	SOCIO-ECOLOGICAL PPUIGS ATTRIBUTE LEVELS CATT Trends of Significance
Social	**MAINTENANCE AND MANAGEMENT**	CLEANLINESS	**Clean - green structure is well maintained or managed. Pavement is not cracked, vegetation is trimmed, grass is mowed often. Not many exposed dirt areas, no dog fouling. No graffiti or rubbish seen outside bins. Benches are clean and sturdy. 'Tidy' green structure.** *Moderate - green structure adequately maintained, some dirty areas.* *Dirty - green structure not well maintained or managed, messy. Pavement cracking and limited grass and vegetation maintenance. If present, buildings and structures/amenities not well maintained or clean. Rubbish and graffiti may be seen. Not a 'Tidy' green structure.*
Social	**MAINTENANCE AND MANAGEMENT**	FACILITIES (AMENITIES)	**Abundant - green structure has many facilities and/or user amenities (e.g. benches, tables, paved areas, toilets, drinking fountain, signage, cafe, bins, etc) throughout.** *Adequate - green structure has a good amount of facilities and/or user amenities* *Inadequate - green structure has few facilities and/or user amenities*
Social	**MAINTENANCE AND MANAGEMENT**	FACILITIES (PATHS)	**Paved - nearly all paths are paved (non-porous)** *Mixed - some non-paved trails and walking tracks & some paved paths and walking/cycling areas* *Unpaved - no paved paths or trails*

HWB BENEFIT	PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	SOCIO-ECOLOGICAL PPUIGS ATTRIBUTE LEVELS CATT Trends of Significance
Psychological	**MAINTENANCE AND MANAGEMENT**	FACILITIES (SOCIABILITY)	*High - the green structure has exposed spaces with many places for social interaction, both formal & informal. There is a designated dog space. Many benches and seating areas, possibility of a playground or communal area. green structure can accommodate large groups.* *Mixed - the green structure has both exposed and communal spaces and more solitary and alone spaces. Not many communal areas but still some spaces for large groups.* **Low - the green structure has mostly solitary and isolated spaces. Not many benches or tables.**
Social	**MAINTENANCE AND MANAGEMENT**	FACILITIES (SOCIABILITY)	**High - the green structure has exposed spaces with many places for social interaction, both formal & informal. There is a designated dog space. Many benches and seating areas, possibility of a playground or communal area. green structure can accommodate large groups.** *Mixed - the green structure has both exposed and communal spaces and more solitary and alone spaces. Not many communal areas but still some spaces for large groups.* *Low - the green structure has mostly solitary and isolated spaces. Not many benches or tables.*
Social	**SAFETY AND SECURITY**	SAFETY and SECURITY	**Safe - many lights and open edges, visibility within and throughout is high.** *Somewhat Safe - some lights and/or some edges are open. Visibility is acceptable at some places.* *Unsafe - minimal or no lights, enclosed and dark edges, low visibility. Many dark areas.*

Table 9.13
PPUIGS Attribute Levels with Significant Relationship Trends to HWB Affordances Noted in Bold
Vantaa CA

9.8 Human Wellbeing and PPUIGS Eco-spatial Characteristic Relationships

This research reported per the CATT that there was no one specific PPUIGS characteristic or attribute level that provides the suite of HWB affordances. Thus, there is no singular 'magic-bullet' PPUIGS factor that correlates to, or positively influences, all the HWB benefits across multiple landscape fragmentation contexts. Many influential relationships do exist, however, particularly when focussing on specific HWB benefits and specific PPUIGS characteristics. For instance some PPUIGS' specific fragmentation aspects were considered 'big hitters' – they provided multiple affordances. The next section will discuss the CATT results according to the three HWB constructs of Psychological, Social and Physical Wellbeing.

9.8.1 HWB and Paisley, Scotland's, PPUIGS' Eco-spatial Characteristics

Psychological Wellbeing PPUIGS Characteristics

The results show that psychological HWB affordances are the most strongly related to the PPUIGS characteristics of the Paisley CA. Within the psychological HWB relationship, three of the four statistically significant relationships are related to the PPUIGS fragmentation characteristic of *Proximity* – including *Integratedness, Connectedness* and *Grouped*. The fourth, *Size – High Density*, is inclusive of the many spatial proximity characteristics. Clearly, psychological-based wellbeing benefits were strongly influenced by PPUIGS characteristics exhibiting connected and unfragmented landscape qualities.

Only two of these four statistically significant relationships exhibited additional trends toward those unfragmented levels or aspects. The results indicate there is a strong statistically significant trend towards a physically connected GS (*Connected*) within an area of many other GS (*High Density*) being associated with a higher probability of receiving a psychological HWB benefit (See Table 9.13A)

Paisley Case Study Area		
PPUIGS Eco-Spatial Characteristic	***Psychological HWB Benefits Only (41% respondents)*** **Psychological Affordances were the Highest % per CA** ***No Characteristics or Levels were considered Significant. This table summarises only those Trends to Statistical Significance and (*) Trends Approaching Statistical Significance (Through CATT Analysis)***	***PPUIGS Characteristic Levels and Descriptions***
Size Characteristics		
Size – Area	**Limited ***	Extensive - green structure separates houses well, not see other houses within green structure or at green structure edges Moderate - green structure separates houses somewhat **Limited - from green structure edge, one can see houses across from them**
Size – Density	**High**	**High Density - green structure is seen nearby** Moderate Density - green structure is seen at a distance but not nearby Low Density - green structure is not seen at all
Size – Largest		
Shape Characteristics		

Paisley Case Study Area		
Shape – Regulation		
Shape – Regulation – Greenness	**Natural ***	*If the green structure has a mixed spatial quality to it, the dominant portion or most used portion determines level* **Natural - green structure feels wild and natural, sense of ruralness to it (e.g. Woodlands)** Moderate - green structure feels neither natural or urban (e.g. Agricutlural and Grazing lands) Urban - green structure feels urban, not very natural or rural at all (e.g. Playing Fields, Civic Plaza, Monument)
Shape - Complexity and Diversity		
Proximity Characteristics		
Proximity - Nearest GS Neighbour	**Connected**	**Connected - green structure is physically connected to another at least 1 side (no street, wall, fence - path ok)** Nearby - one can see another green structure (50m minimum width facing) from most parts of the green structure, but not physically connected. A street, rail or wall/fence may separate the green structure. Separated - green structure is alone & separate, not physically or visually connected, cannot see another green structure from any parts of green structure

Paisley Case Study Area		
Proximity - Isolation and Connectivity	**Grouped**	*When viewed without land ownership boundaries:* **Grouped - considered 1 in a group of many green structures nearby** Moderate - considered 1 in a group of few green structures nearby Isolated - only green structure, none in nearby group
Proximity - Level of Coherence	**Integrated**	**Integrated - green structure is part of bigger, physically and spatially (e.g. garden within housing, village green within neighbourhood, playground within larger park) or area within larger green structure (e.g. Regional or Country Park)** Autonomous - green structure sits independently - by itself - and is autonomous and not part of a bigger park (e.g. Regional or Country Park) Linear Corridor (river walk, bicycle route, etc).
Edge Characteristics		
Edge - Total Edge	**Few ***	Numerous - green structure has many edges (8+) Moderate - green structure has a moderate amount of edges (4-8) **Few - green structure has few edges (3-4)**
Edge - Longest Edge		
Edge - Edge Density		

Paisley Case Study Area		
Level of Green Characteristics		
Level of Green - Veg. Composition	**Deciduous ***	**Deciduous - green structure with predominately deciduous vegetation types** Evergreen - green structure with predominately evergreen vegetation types Mixed - green structure with a fair mixture of different (evergreen and deciduous) vegetation types green structure Play fields or Grass - green structure which is a playing field or a grass area (including grazing and agricultural or farming fields)
Level of Green - Veg. Composition - Setting		
Level of Green - Vegetation Structure – Horizontal		
Level of Green - Vegetation Structure – Vertical		
Level of Green - Vegetation Structure – Density		

Paisley Case Study Area		
Level of Green - Vegetation Structure -Visibility	**Extensive ***	**Extensive - within green structure, many (3+) long and expansive views, within green structure and/or out from green structure** Moderate - within green structure, a few (1-3) extensive views, some areas with limited visibility Limited - within green structure, no long or expansive views either within green structure or out from green structure, limited visibility
Level of Green - Proximity to Heavy Traffic Road		
Maintenance and Management Characteristics		
Maintenance and Management - Cleanliness		
Maintenance and Management - Facilities		
Maintenance and Management – Facilities - Sociability		
Safety and Security		

Table 9.13A
PPUIGS Attribute Levels with Significant Relationship Trends to Psychological Affordances
Paisley, Scotland CA

For Paisley, then, Psychological HWB benefits are most afforded through interaction with Proximity Characteristics more than any other eco-spatial characteristic. This trend statistic is interpreted within the notion of landscape change and connectivity within the PolyPUR – as the PPUIGS become more connected and the region's GS become more dense overall, Pyschological HWB affordances would likely increase. Examples of connected and high density PPUIGS include a GS such as a village green or garden within a larger housing area or estate, as well as a small playground area or woodland found within a much larger park or Regional Park (See Figure 9.92).



Figure 9.92
Psychological HWB Affordances
(Paisley, Scotland - Barsahaw Park)

In the image above, Barshaw Park has many smaller areas within its physical boundaries illustrating inregration and grouping within a larger GS (e.g. Nature Corner, Playfield, Fishing – Boating Pond, Formal Garden Area) and connection to other GS such as the golf course to the North and Playfields to the Southwest.

In summary, these results show that Paisley CA respondents were able to mentally relax, de-stress and enjoy nature more in a GS that exhibits characteristics and levels indicative of a PPUIGS within a less fragmented landscape. Potential reasons for this relationship are many. As described earlier the relationship between PPUIGS and psychological HWB includes aspects of interpersonal wellbeing, comfortability, a feeling of autonomy and relaxation, spiritual connectedness and a connectedness to nature, a restoration of emotional wellbeing, cognitive functioning, and stress reduction, among others. It may be that Paisley CA respondents felt these HWB aspects more within PPUIGS that were densely integrated and physically connected than other PPUIGS because of an increased sense of the expansiveness or overall size-perception. Or perhaps these types of

PPUIGS provided a means of ‘escape’ as the presence of anthropocentric elements seem minimised in these larger settings.

This evidence supports the descriptive analyses conducted which reported that the top three GS within the Paisley CA to provide psychological-based HWB benefits were Pollock Park, Barshaw Park, and Brodie Park, all of which supported the aforementioned levels of their eco-spatial characteristics. In addition, these three are inclusive of the overall Parks, Gardens and Amenity GS typology in which psychological-based responses were noted in 60% of those locations.

Social Wellbeing PPUIGS Characteristics

Within the social HWB affordance relationship, only one statistically significant relationship exists in respect to PPUIGS characteristics - *Edge – Dense Edge.* This characteristic also exhibited a trend. This suggests that residents are more likely to receive a social-based HWB affordance from PPUIGS with edges of either vegetation (e.g. trees, shrubs) or built structures (e.g. fences, walls, houses, etc.) which that blocks views into the PPUIGS. This is not a privacy or visibility aspect, only the physical structure of the PPUIGS edge itself – they are not transparent or open edges. Examples of these dense edged PPUIGS include a managed woodland or forest, hedgerows along an agricultural parcel, high walls along large estates, and fences seperating housing areas (See Figure 9.93).



Figure 9.93
Social HWB Affordances – Dense Edges
(Paisley, Scotland – Fergulsie Park)

In summary, results show that Paisley CA respondents were able to spend time with family and friends, socialise and gossip more in a GS that exhibits characteristics and levels indicative of a PPUIGS within a more fragmented landscape.

This evidence supports the descriptive analyses conducted which reported the overall Parks, Gardens and Amenity GS typologie in which social-based responses were noted in 70% of those locations.

Physical Wellbeing PPUIGS Characteristics

Within the physical HWB affordance relationship, only two statistically significant relationships exist in respect to PPUIGS characteristics: *Vegetation Structure – Open Density* and *Maintenance and Management – Moderate Cleanliness*. This suggests that residents are more likely to receive a physical-based HWB affordance from PPUIGS with a very open vegetation structure (i.e. both horizontal and vertical vegetation is considered spatially not dense or clustered) with sparse or few plantings such as a large grass area or playfield. The cleanliness aspect of these 'open' PPUIGS is just moderate – there are some dirty areas, but

overall, it is considered adequately maintained. Though no trends of significance are noted, the *Linear Corridor* level within the *Proximity – Coherence* characteristic is approaching statistical significance (See Figure 9.94).



Figure 9.94
Physical HWB Affordances – Open Vegetation Structure Density (top – Foxbar Park) and Moderate Cleanliness (bottom – Maxwelton Park) (Paisley, Scotland)=

In summary, these results indicate the tendency for individuals within the Paisley CA to participate in physical HWB activities, such as playing games and sports, walking, running or cycling in a GS that exhibits characteristics and levels indicative of a PPUIGS within a more fragmented landscape. Linear corridors are a common morphology within fragmented PURs.

This evidence supports the descriptive analyses conducted which reported that the top three GS within the Paisley CA to provide physical-based HWB affordance were Pollock Park, Barshaw Park, and Glennifer Braes Country Park, all of which supported the aforementioned levels of their eco-spatial characteristics. In addition, these three are inclusive of the overall Parks, Gardens and Amenity GS typology in which psychological-based responses were noted in 51% of those locations.

Summary - Human Wellbeing and Paisley, Scotland's PPUIGS Eco-spatial Characteristics

This research reports that for Paisley CA respondents, there is no single statistical significant PPUIGS eco-spatial characteristic shared across all three HWB affordance constructs.

Furthermore, there is no single PPUIGS attribute level shared across all three HWB affordance constructs that exhibits a trend, though one trend shared between two affordances: having few edges – an indicator of less fragmentation. In fact, the results indicate that very dissimilar PPUIGS attribute levels exhibit trends towards both less fragmented and more fragmented landscapes. For example, whereas physical HWB ffordances are associated with a characteristic of less proximity and *Separation*, psychological HWB affordances are associated with a characteristic of closer proximity and *Connectedness*. Additionally, both psychological and social HWB affordances reported trends toward higher density PPUIGS, often physically connected, but physical HWB benefits illustrate that low density and linear corridors are more conducive to delivering such benefits.

The frequency distributions found in respect to the Paisley CA respondent's PPUIGS visitations and interactions provide further insights into those PPUIGS eco-spatial characteristics and levels that were noted as providing HWB benefits.

The following attribute levels are reported as being the most common (i.e. highes frequency) among the three HWB affordances, as well as the most consistent in their associated trend levels in parens:

Shape - Complexity and Diversity (Simple)
Proximity - Isolation and Connectivity (Grouped)
Level of Green - Veg. Composition – Setting (Semi-Natural)
Level of Green - Vegetation Structure – Horizontal (Uniform)
Level of Green - Vegetation Structure – Vertical (Clustered)
Level of Green - Proximity to Heavy Traffic Road (Close)
Level of Green - Vegetation Structure – Visibility (Extensive)
Maintenance and Management - Facilities – Sociability (High)
Safety and Security (Somewhat)

Figure 9.95
PPUIGS Attribute Level Frequencies and HWB Affordances
Paisley CA

Stated another way, these frequency results and associated trend level indicate that HWB affordances are, generally, more likely to be augmented when a PPUIGS is simple and regular in shape, with three or four sides, and is one of a group of many nearby or connected GS. These multi-HWB beneficial PPUIGS also typically contain mostly grass or low shrubs and clustered and clumped trees, which feel semi-natural or somewhat wild and have many long views within them. These PPUIGS are most often close to a major motorway or other heavy trafficked road with exposed spaces and many places for social interaction, both formal and informal. They are also likely to have many benches and seating areas, some lights and some edges that are open with adequate internal visibility, and perhaps a playground or communal area that can accommodate large groups (See Figure 9.96).



Figure 9.96
GS with Multiple HWB Affordances
(Paisley, Scotland – Glennifer Braes County Park – Top; Barsahw Park, Bottom)

9.8.2 HWB and Vantaa, Finland's, PPUIGS' Eco-spatial Characteristics

Psychological Wellbeing PPUIGS Characteristics

The CATT results indicate that four statistically significant relationships exist between the PPUIGS eco-spatial characteristics and psychological-based HWB affordances within the Vantaa CA. These include the PPUIGS fragmentation

characteristic of *Maintenance and Management* – including *Mixed Sociability* and *Mixed Pathway Treatments* as well as *Shape – Natural Regulation* and *Greeness Composition – Natural.* In this regards, Psychological HWB affordances are strongly influenced by more naturalistic, informal vegetation qualities but with signs of human use and activity (See Figure 9.97).

Notably, two of these four characteristic levels also show statistically significant trends, indicating that a wild, naturalistic and/or rural GS with no formal but some limited informal recreational opportunities, within a mostly natural or naturalistic vegetative setting is associated with a higher probability of receiving a psychological HWB affordance. This trend statistic is interpreted within the notion of landscape change and connectivity within the PolyPUR – as the PPUIGS become more urbanised and impacted through human development and land use modification, pyschological HWB affordances would likely decrease. Examples of natural, informal PPUIGS include a nature parks and wilderness areas or preserves. GS with mostly informal structure to the naturalistic/indigeneous vegetation include woodlands and wetlands (See Figure 9.97).





Figure 9.97
Psychological HWB Affordances – Natural Shape and Composition, Mixed Pathways, and Moderate Maintenance
(Vantaa, Finland – Fastholma GS)

This evidence supports the descriptive analyses conducted which reported that the top three GS to provide psychological-based HWB affordance were Lammassaari Island, Paloheina Woodlands, and Fastholma Green Space, all of which supported the aforementioned levels of their eco-spatial characteristics. In addition, these three are inclusive of the overall Woodlands, Grasslands and AG GS typology in which psychological-based responses were noted in 46% of those locations.

These results support other research findings in Finland. For example, surveys have reported that proximity to nature is considered important in housing developments and residents usually favour natural environments (Kyttä and Kahila, 2006; Korpela and Ylen, 2007; Tyrväinen et al., 2007b).

In summary, the results show that Vantaa CA respondents were able to mentally relax, de-stress and enjoy nature more in a GS that exhibits characteristics and levels indicative of a PPUIGS within a less fragmented landscape.

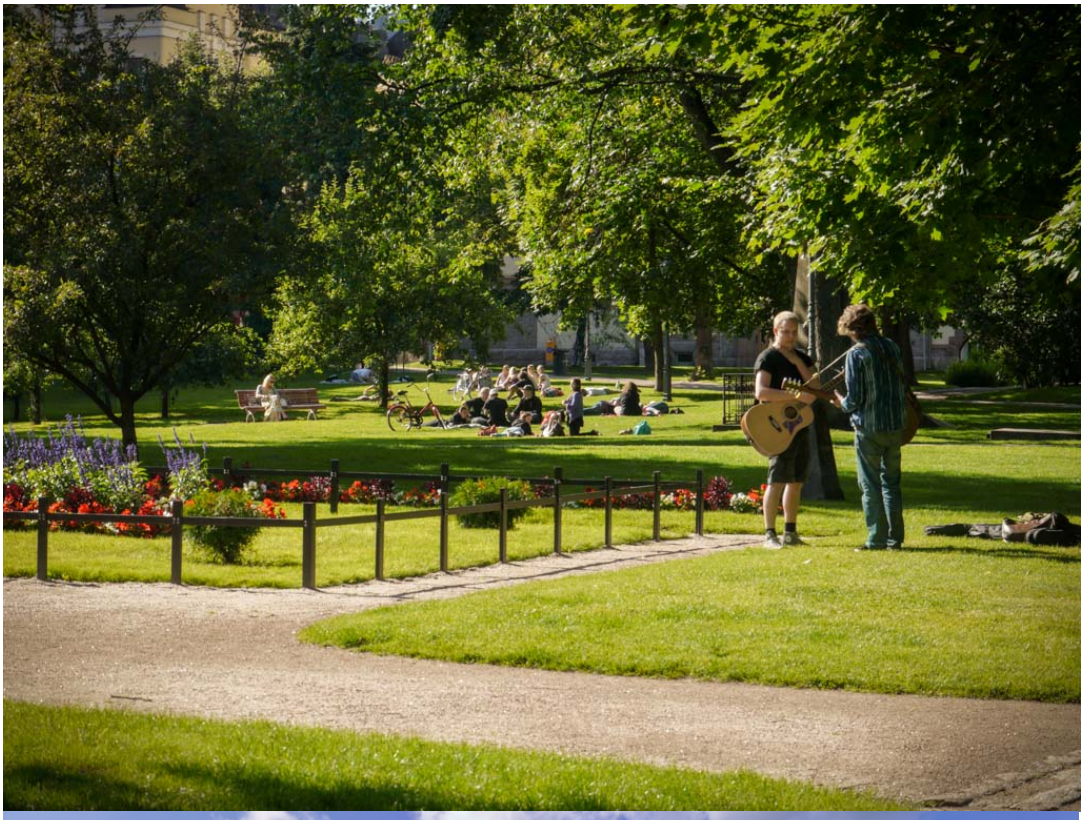
Social Wellbeing PPUIGS Characteristics

The results show that social-based affordances are the most strongly related HWB constructs to the PPUIGS characteristics of the Vantaa CA (n=15). Within this social HWB affordance relationship, interesting patterns emerge. All four of the *Maintenance and Management* Attributes were statistically significant (*Clean, Adequate Facilities, Unpaved Paths, Mixed Sociability*) indicating that this characteristic is highly influential in providing social HWB benefits, as were five of the seven *Level of Greenness* attributes (*Moderate Visibility, Open Density, Clustered Vert. Vegetation, Natural Setting, Uniform Horiz. Vegatation*), two of the three *Proximity* attributes (*Grouped* and *Connected GS*) and two of the three *Edge* attributes (*Least Edge Length, Transparent Density*). Overall, these results clearly indicate that many PPUIGS' fragmentation eco-spatial characteristics, both structural and non structural, are very influential in respect to the receipt of social HWB affordances when residents interact with the GS.

Additionally, 5 of these 15 characteristics' attribute level relationship trends are also statistically significant in respect to social HWB benefits. These significant characteristic trends include having one of the shortest edges in the CA (*Least Edge Length*), a grassed or minimally diverse vegetation context (*Uniform Horizontal Vegetation Structure*) with a sense of openness and sparse plantings (*Open Density Vegetation Structure)* and tidy and well maintained (*Clean*) with many lights and high visibility within (*Safe)*. This trend statistic is interpreted within the notion of landscape change and connectivity within the PolyPUR – as the PPUIGS become more anthropocised and managed, and the region's GS become fragmented and spatially smaller, Social HWB affordances would likely increase. Examples of these PPUIGS include a GS such as a village green or urban park/parklet, playfields, cemeteries, playgrounds and picnic areas (See Figure 9.98).


Google






Google



Figure 9.98
Social HWB Affordances – Moderate Visibility, Open Density, Uniform Horizontal Vegetation, Clean, Safe, Transparent Edges (Vantaa, Finland)

This evidence mostly supports the descriptive analyses that reported the top three GS within the Vantaa CA to provide social-based HWB affordances were Lammassaari Island, the Faastholma Green Space and the Uutela Recreation Area, all of which have similar eco-spatial characteristics and levels. Interestingly, all three of these social-based HWB PPUIGS are considered a different Typology. The Fastholma Green Space, however, was identified as having a 'Low' level of social spaces – noting mostly isolated and solitary-use spaces. This indicates, perhaps, that the social benefits are achieved through walking together or informal, spontaneous, interaction, rather than structured family or group activities.

In summary, these results suggest that individuals receive more social-based wellbeing benefits from spending time with friends and family, group picnics or activities, catching up and gossiping within a GS that exhibits characteristics and levels indicative of a PPUIGS within a more fragmented landscape.

There are many potential reasons for these significant relationships. As described earlier in Chapter 5, the relationship between GS and social HWB includes aspects of community and personal identity, social cohesion or a 'sense of community', cultural-value sharing, family bonding and instilling a sense of

belonging among others. This evidence suggests that Vantaa CA respondents felt these HWB aspects more within PPUIGS that were more fragmented, and with the characteristics described above. Perhaps these types of PPUIGS afforded a means of social and socio-cultural sharing conducted not within an indoor setting, but within the landscape, a landscape which Finns strongly associate with their identity.

Physical Wellbeing PPUIGS Characteristics

Within the physical HWB affordance relationship, there is only one statistically significant PPUIGS characteristic: *Proximity – Level of Coherence - Integrated*. This suggests that residents are influenced by the proximity, spatial organisation and ease of comprehension aspects of PPUIGS when receiving physical HWB benefits (i.e. GS is part of bigger GS). Importantly, the attribute level is also statistically significant, but as a trend moving toward a *Linear* structured PPUIGS (See Table 9.13B).

Vantaa Case Study Area		
PPUIGS Eco-Spatial Characteristic	***Physical HWB Benefits (54% respondents)*** **Physical Affordances were the Highest % per CA** **** denotes Trends to Statistical Significance and Trends Approaching Statistical Significance (Through CATT Analysis)***	***PPUIGS Characteristic Levels and Descriptions***
Size Characteristics		
Size – Area		
Size – Density		
Size – Largest		
Shape Characteristics		
Shape – Regulation		
Shape – Regulation – Greenness	**Urban ***	*If the green structure has a mixed spatial quality to it, the dominant portion or most used portion determines level* **Natural - green structure feels wild and natural, sense of ruralness to it (e.g. Woodlands)** Moderate - green structure feels neither natural or urban (e.g. Agricutlural and Grazing lands) Urban - green structure feels urban, not very natural or rural at all (e.g. Playing Fields, Civic Plaza, Monument)
Shape - Complexity and Diversity		

Vantaa Case Study Area		
Proximity Characteristics		
Proximity - Nearest GS Neighbour		
Proximity - Isolation and Connectivity		
Proximity - Level of Coherence	**Integrated**	**Integrated - green structure is part of bigger, physically and spatially (e.g. garden within housing, village green within neighbourhood, playground within larger park) or area within larger green structure (e.g. Regional or Country Park)** Autonomous - green structure sits independently - by itself - and is autonomous and not part of a bigger park (e.g. Regional or Country Park) Linear Corridor (river walk, bicycle route, etc).
Edge Characteristics		
Edge - Total Edge		
Edge - Longest Edge		
Edge - Edge Density		
Level of Green Characteristics		
Level of Green - Veg. Composition		
Level of Green - Veg. Composition - Setting		
Level of Green - Vegetation Structure – Horizontal		

Vantaa Case Study Area		
Level of Green - Vegetation Structure – Vertical	**Diverse and Random ***	*Deciduous and/or Coniferous Vegetation Types, Vertical is over 4' height:* **Diverse and Random - green structure with many different vertical vegetation types whose diversity is visually dominant. Distribution is many and informal/wild.** Clustered - a few or many different vertical vegetation types, but not present in all areas of green structure. Vertical vegetation is distributed only in clumps or massed areas. Uniform - green structure with hardly any or different vertical vegetation types (e.g. allees, walkways). Little vertical vegetation distribution within green structure (many open spaces). None visually dominant.
Level of Green - Vegetation Structure – Density	***Dense **	*Deciduous, Mixed and Coniferous Vegetation, Horizontal and Vertical, Considered Spatially:* **Dense - within green structure, many dense or clustered plantings, crowded and tightly-packed.** Moderate - within green structure, both dense and sparse areas Open - within green structure, sparse plantings, few plantings, spacious (mostly grass areas, play fields).
Level of Green - Vegetation Structure -Visibility		
Level of Green - Proximity to Heavy Traffic Road		
Maintenance and Management Characteristics		
Maintenance and Management - Cleanliness		
Maintenance and Management - Facilities		

Vantaa Case Study Area		
Maintenance and Management – Facilities - Sociability		
Safety and Security		

Table 9.13B
PPUIGS Attribute Levels with Significant Relationship Trends to Physical Affordances
Vantaa, Finland CA

For Vantaa, then, Physical HWB benefits are most afforded through interaction with Greeness Level Characteristics more than any other eco-spatial characteristic. This trend statistic is interpreted within the notion of landscape change and connectivity within the PolyPUR – as the PPUIGS become more connected and the region's GS become more dense overall, Physical HWB affordances would likely increase. Examples of diverse & random and dense vegetation structure PPUIGS include a GS such as a national park or leftover GS or lightly managed woodland (See Figure 9.99)

This makes sense within Vantaa's PolyPUR undergoing landscape transformation and fragmentation. Also, these characterstics are typical of the

’Green Fingers’. Examples of these linear - integrated PPUIGS include athletic fields, riverside or shoreline pathways, woodland trails, and other narrow yet long recreational opportunities to cycle, jog, run, or walk, and exercise (See Figure 9.99).



Figure 9.99
Physical HWB Affordances – Diverse & Random / Dense Vegetation Structure (top) and Integrated / Urban GS (bottom) (Vantaa, Finland)

In summary, it is difficult to clearly interpret these results. Currently, Vantaa respondents receive Physical HWB affordances from a less fragmented PolyPUR context and PPUIGS, but the trend is moving towards more fragmentation within linear-type PPUIGS. Furthermore, this is only one characteristic (Proximity - *Coherence*) to interpret fragmentation influence. However, reviewing the other relationship trends not statistically significant (*Shape – Regulation – Urban level of Greeness* and *Level of Green – Vegetation Structure – Dense*), they are predominately moving towards a more fragmented landscape and PPUIGS context. Thus these results indicate the tendency for individuals within the Vantaa CA to participate in physical HWB activities, such as playing games and sports, walking, running or cycling in a GS that exhibits characteristics and levels indicative of a PPUIGS within a more fragmented landscape. Linear corridors are a common morphology within fragmented PULs.

Summary - Human Wellbeing and Vantaa's PPUIGS Eco-spatial Characteristics

This research reports that for Vantaa's CA respondents, there is one single statistically significant PPUIGS' eco-spatial characteristic shared across all three HWB affordance constructs (Table 9.14) and one shared across two (Table 9.15), no shared attributes were reported.

Maintenance and Management

Table 9.14
PPUIGS Characteristic Influencing 3 HWB Affordances
Vantaa CA

Proximity

Table 9.15
PPUIGS Characteristic Influencing 2 HWB Affordances
Vantaa CA

Furthermore, there is no single PPUIGS statistically significant attribute level shared across all three or even two HWB affordance constructs that exhibits a trend. In fact, the results indicate that very dissimilar PPUIGS attribute levels exhibit trends towards both less fragmented and more fragmented landscapes. For example, whereas social HWB affordance statistically significant trends are

associated with a characteristic of an *Urban Setting* for *Vegetation Composition*, psychological HWB affordances are associated with a characteristic of a *Natural Setting* for *Vegetation Composition.* This also occurs with the *Maintenance and Management* characteristics of *Abundant Facilities* and *High Sociability* for social-based HWB affordances vs. *Inadequate Facilities* and *Low Sociability* for psychological HWB affordances.

The frequency distributions found within the Vantaa CA respondent's PPUIGS visitation and interaction provide further insights into those PPUIGS eco-spatial characteristics and levels that were noted as providing HWB benefits. The following attribute levels are reported as having the highest frequency among all three HWB affordances, as well as the most consistency in their associated trend levels in parens:

Size - Area (Extensive)
Level of Green - Veg. Composition (Mixed)
Level of Green - Vegetation Structure Horizontal (Uniform)
Level of Green - Proximity to Heavy Traffic Road (Close)

Figure 9.100
PPUIGS Attribute Level Frequencies and HWB Affordances
Vantaa CA

Stated another way, these frequency results indicate that HWB benefits are, generally, more likely to be available when a PPUIGS is large and extensive in size and separates views to other built structures within them. These multi-HWB beneficial PPUIGS also typically contain mostly grass or low shrubs and are most often close to a major motorway or other heavily trafficked road (See Figure 9.101).



Figure 9.101
Multiple HWB Affordances – Large Size and Uniform Horizontal Vegatation GS
(Vantaa, Finland)

An important factor in the HWB affordance and eco-spatial characteristic relationships found within Finland is the high-number of ‘leisure-homes’ or ‘forest cabins’. One in every seven households in Finland (15%) own this type of second-home (Free-time Residences 2000, 2001). Culturally, these homes are used by the owner’s family and adult children, or by siblings with their families. In this regard, about 40% of the Finnish population has access to these types of non-urban homes on a regular basis. Two-thirds of the leisure homes are located in the same province as the primary residence of the owner, with one-third being located in the same municipality. Finland and the Greater Helsinki Urban Region offer lakes and other waterside locations for these homes, as well as a vast amount of forest. As such, leisure homes are concentrated on the south coast and in the lake district of central and eastern Finland. Forests are the dominant green structure typology in Finland and the GHUR (Metsäntutkimuslaitos, 2011). In a recent study (Sievänen and

Neuvonen, 2007), the average distance to a forest from these leisure homes was 700m and the average distance to a water body was 2km.

9.8.3 Comparison of Human Wellbeing and PPUIGS Eco-spatial Characteristic Relationships

Psychological Wellbeing PPUIGS Characteristic Comparison

Psychological wellbeing is perhaps the most researched aspect of GS human interaction. The only statistically significant characteristic shared between the two CAs is *Proximity*, and no attribute level trends are shared in respect to psychological HWB affordances. Although both CAs strongly indicate that a less fragmented PPUIGS and landscape context provide psychological HWB affordances, the PPUIGS locations that provided psychological HWB affordances for both samples were, most often, not considered to lie within the less-fragmented geographic areas of the PolyPUR, such as the rural hinterlands or 'fringe' zones, but within the polycentric conurbation's more central urban region. This indicates that scale matters and that there are specific, less-fragmented, eco-spatial characteristic attributes of PPUIGS found within the overall fragmented PUL that serve to provide psychological-based HWB benefits such as *Naturalness* and *Connectivity*. These results echoed the findings of previous research, which reported that GS provide restorative and stress-relieving benefits (Grahn and Stigsdotter, 2003) and that woodlands, parks and other GS within urban regions and urbanised environments have a significant capacity to facilitate relaxation and stress relief (Chiesura, 2004, Coles and Bussey, 2001, Bell et al., 2003). Research supports the view that nature and GS affects HWB and that people prefer more rural than formalised GS, thereby increasing a sense of peace and quiet and, building on this, Kaplan's (1995) research also reported the concept that the extent of, or coherence within, GS provides a sense of separation from a more urban setting, a conclusion also supported by Coles and Bussey (2000).

Interestingly, the results of this research do not support the findings of Kaplan and others that suggest that characteristics of complexity are important for mental

wellbeing, since these characteristics in this research had no statistical significance or trend, although environmental psychological research within the concept of complexity typically assesses variables and characteristics more specifically than this research's PPUIGS Characteristic Performance Index.

Social Wellbeing PPUIGS Characteristic Comparison

Although the social HWB benefits were the least-frequented HWB affordance received through interaction with PPUGS in both samples, the PPUIGS characteristics of Vantaa's CA is considered particularly conducive to providing social HWB affordances. The individuals within the Vantaa region spend time with family and/or friends, whether talking or doing activities together in fragmented, informal, naturalistic PPUIGS that are moderately safe in addition to being very clean and tidy. There were no statistically significant characteristics attribute levels or trends shared between the two CAs though the *Edge* characteristic indicative of fragmentation qualities was present in both samples.

The PPUIGS characteristic and attribute level results of this relationship are supported by the studies of Sullivan et al (2004) and Coley et al (1997), who compared densely vegetated GS with many trees to those more open and barren ones in the US, finding, through behavioural observation, that not only were the densely vegetated GS utilised more, but that they were utilised for social activities and for larger groups of people. This result was supported by Kweon et al. (1998) who, in an urban community study among older adults, reported that social integration, a component of wellbeing, can be increased through urban greenery and the provision of GS. Mass et al. (2009) reported a positive relationship between overall GS density within a region of the Netherlands and individuals feeling less lonely and less lacking in social support.

Research encompassing social HWB has centred on the role of GS in facilitating overall social interaction (Kuo and Sullivan, 2001), often with friends and family (Macnaghten and Urry, 2000). As discussed previously, this research did not include data in respect to GS visits with others, although it can be inferred that visits to PPUIGS specifically for social HWB benefits include other

individuals. Studies have shown that there are many social activities within GS and that these also influence larger-scale community cohesion and social interaction (Flap and Volker, 2005) such as families and interest groups through outdoor events. The research in this thesis, however, did not account for GS interaction with partners, children, friends, groups or other family members, and thus does not provide a measure of the associations between demographic characteristics and if/who they visited PPUIGS with. This factor could influence the reception of HWB benefits, particularly through the concept of synergistic effects such as social benefits of jogging with someone noted previously. Interestingly, a study by Scopelliti and Giuliani (2004) found that social interaction within urban environments (not UGS, per se) could increase mental restoration, but only if that space was perceived as 'safe'.

Physical Wellbeing PPUIGS Characteristic Comparison

Results strongly indicate that a linear shaped PPUIGS, such as a green corridor or pathway along a river, provide physical HWB affordances to both respondent samples. This is somewhat supported by Gearin and Kahle's (2006) study in the US, which suggested that adults preferred more defined and organised GS for recreation. Additionally, both CAs clearly indicate that a more fragmented PPUIGS and landscape context provide physical-based HWB benefits. The characteristic of proximity, however, varies between the CAs. Whereas less proximal PPUIGS provides physical HWB affordances in the Paisley CA, more contiguous and adjacent PPUIGS is required for the Vantaa CA. These divergent results reflect the literature. Whereas Giles-Corti and Donovan (2002) reported that nearby GS added to physical HWB, Duncan and Mummery (2005) found that people who were more than 0.6 km away from a Park type GS, and with overall low levels of GS connectivity, were more likely participate in physical activities than those who lived closer and had more direct routes. Explanations offered by the authors for this included the suggestion that more active people may be more likely to overcome barriers to physical activity, i.e. go outside their area and perhaps walk further to a park or GS.

Physical wellbeing is generally considered a benefit as a result of the interaction with GS through exercise and recreation. Research clearly supports GS as having a positive effect on HWB and health, but Hansmann et al. (2007) reported that these effects were greater when participating in recreation-based behaviours. Although there are subtle differences when walking is defined as a leisure activity or as a physical activity, this research codified walking as a physical activity, as it was also grouped with jogging and running, indicating a physical activity to respondents.

The term 'recreation' is predominant in discussions on the use of green structures in Finland. Recreation is defined as including the most popular activities of walking, swimming in natural waters, cycling, and just being in nature with no special activity (Söderman et al., 2011). These aspects of recreation cover both the psychological wellbeing and physical wellbeing affordance concepts of GS. It should be noted that The Finnish National Outdoor Recreation Demand Inventory reported that a forest was encountered on about 90% of recreation visits that water was the primary destination of 33% of close-to-home recreation visits and that two-thirds of recreation visits (68%) took place within walking distance from the residence (i.e. leisure-based or primary home residence) (The Finnish National Outdoor Recreation Demand Inventory, 2008–2011, LVVI2). This research reported similar results in respect to distance. The prior research, however, was based on nationwide-data collection, rather than the specific CAs focused on in this research. Exercise and physical health are a subjective ability, however, and most research focuses on these two concepts when discussing GS interaction and outcomes.

Within the Vantaa CA, woodlands primarily provided the physical HWB affordance, but woodlands were also the primary supplier of the other HWB affordances. Thus, woodlands in the Vantaa CA are very important multi-beneficial PPUIGS where respondents receive multiple HWB benefits. In regards to physical HWB and Vantaa's woodlands, such interaction can be viewed as 'green exercise' (Pretty et al., 2005) where the particular benefits of exercising within a GS are *synergistic* (i.e. benefits of walking/jogging/running/playing sports, etc. ***and*** being

in a GS together with others *as well as* the additional psychological benefits accruing from such GS environments - e.g. Mitchell, 2014). This multi-functional notion is supported by Krenichyn's (2006) research, where it was reported that recreation in a park-like, natural, setting provided different views, experiences and sensory inputs than running on streets. Furthermore, there are also links between participating in physical activities within GS and improved mental health (Pretty et al., 2007; Thompson and Apinsall, 2011) and social wellbeing (Kuo et al., 1998; Groenewegen et al., 2006). Additionally, women who participated in wilderness experiences reported that they valued the possibilities of social interaction and the supportiveness of the group (Friedrickson and Anderson, 1999). In the literature, however, there is limited amount of information as to which GS facilities and features encourage activity.

HWB and PPUIGS Characteristic Comparison Summary

Overall, the levels of fragmentation which reported satistically significant trend results to impact HWB vary between affordance constructs but are shared between the CAs as shown below:

Affordance	Paisley CA	Vantaa CA
Physical HWB	More Fragmented	More Fragmented
Social HWB	More Fragmented	More Fragmented
Psychological HWB	Less Fragmented	Less Fragmented

Table 9.16
PPUIGS Fragmentation Levels and HWB Affordances

Regarding the strength of the relationship between the two CAs' statistically significant attribute levels, the trend results indicate that there is stronger evidence of a significant relationship between the strongest three PPUIGS characteristic levels of the Vantaa, CA and social HWB benefits, than the strongest three of the Paisley CA and psychological HWB benefits. This comparison simply means that Vantaa respondents are more likely to receive such HWB affordances through interaction with PPUIGS than the Paisley CA respondents and their PPUGIS.

Another important result is the shared PPUIGS characteristic of *Proximity*, which shows that, even though the PPUIGS interacted within the Vantaa CA

include *Natural Levels of Greenness* for the respondents, these PPUIGS are also more fragmented in complexity, edge and shape characteristics, characteristics not typically associated with 'natural' GS, but more with anthropocised or 'urban' GS. These and other reported characteristics found within the FRAGSTAT and the Case Study analyses do indicate a distinctly fragmented PPUIGS for the Vantaa CA and 10km extension, albeit less fragmented than Paisley.

None of the three *Proximity* characteristic attributes selected changed between the CAs, however respondents in both selected *Connected, Grouped, Integrated PPUIGS*. This is interesting, since even though Vantaa's morphological structure is, overall, considered fragmented, there is a proximal structure – a physical coherence (i.e. Green Fingers) – to the Vantaa's PPUIGS even within a noted fragmented state.

Interestingly, each of the three levels of *Edge - Density* within the Paisley CA reported a different HWB affordance, illustrating that a diversity of edge densities offers a diversity of HWB benefits. Similarly each of the three levels of *Vegetation Structure - Density* within the Vantaa CA reported a different HWB affordance. This may be due to the large number of forested and numerously edged, mixed vegetation, and natural vegetation characteristics of the GS within Vantaa's CA, as Forests are a significant component of its land cover. Overall, the characteristic of Density seems to provide varied HWB affordances within PPUIGS of both CAs.

The descriptive analysis and statistical significant trend results of the non-structural characteristics also show interesting comparative relationships between both CAs. Within the Paisley CA, each of the top three psychological HWB PPUIGS had a 'Parks and Gardens and Amenity GS' typology, whereas, for the Vantaa CA, its top three noted HWB for social-based affordances each included a different typology, only one of which was a 'Parks and Gardens and Amenity GS'. This suggests that respondents within Paisley consistently achieve psychological HWB affordances through PPUIGS identified as 'Parks and Gardens and Amenity GS', whereas the respondents within the Vantaa CA are able to receive social HWB benefits from more diverse GS typologies and settings.

However, why did the Vantaa CA respondents receive fewer Social HWB affordances within what is considered a less-fragmented GS landscape context than those respondents within the more-fragmented Paisley CA GS landscape context? First, perhaps respondents in the Vantaa CA are just more social than those within the Paisley CA; thus they are able to be social in many varying, different GS contexts and typologies. Second, perhaps respondents in the Vantaa CA receive their social-based HWB benefits through other outdoor environments and GS, or other spaces including community halls and family cabins, and, perhaps, stronger familial ties.

Though there were many singular markers for PPUIGS affordances, there were no consistent patterns in the results for that PPUIGS being selected by respondents only once. Studies of GS typologies, such as domestic and community gardens (Guitart et al., 2012), suggest that GS qualities vary within and between GS settings, and that these different qualities may not provide the same benefits to all individuals. Research on the provision of particular values (e.g., improving psychological wellbeing outcomes) as related to the particular ecological qualities of GS is growing, although remains primarily focused on UGS (Jorgensen and Gobster, 2010; Fuller et al., 2007; Konijnendijk et al., 2013).

Chapter 10 - Discussion of Results

10.1 Introduction

The core of this research considers: *How much, what kinds, and what characteristics are important in interstitial green spaces in order to provide human wellbeing benefits to residents in emergent, peri-urban, polycentric regions? And what are the human wellbeing benefits produced by these unique green spaces and green structures?* This enquiry and the associated research questions are answered through the concept of Landscape of Affordances as expressed in Chapter 5 and Figure 5.2 and repeated here in Figure 10.1. In this regard, this research's multiple variables and factors – Individual Factors, Landscape Factors (Spatial and Aspatial), and HWB Interaction Factors – are analysed through an individual's interaction with PPUIGS.

Figure 10.1 and 10.2 places the five factors influencing the benefits to an individual's wellbeing achieved when interacting with PPUIGS. This diagram provides a valuable tool that integrates often disparate and independent elements within HWB and GS studies, highlighting the importance of socio-ecological influences found within PULs and documented within the PPUIGS Characteristics Performance Index in Figure 4.3. The physical features of a GS and the benefits achieved by individuals interacting with those GS, as well as the individual's characteristics, provide a more direct means to investigate and measure this relationship (Giles-Corti, 2006) and the GS's performance.

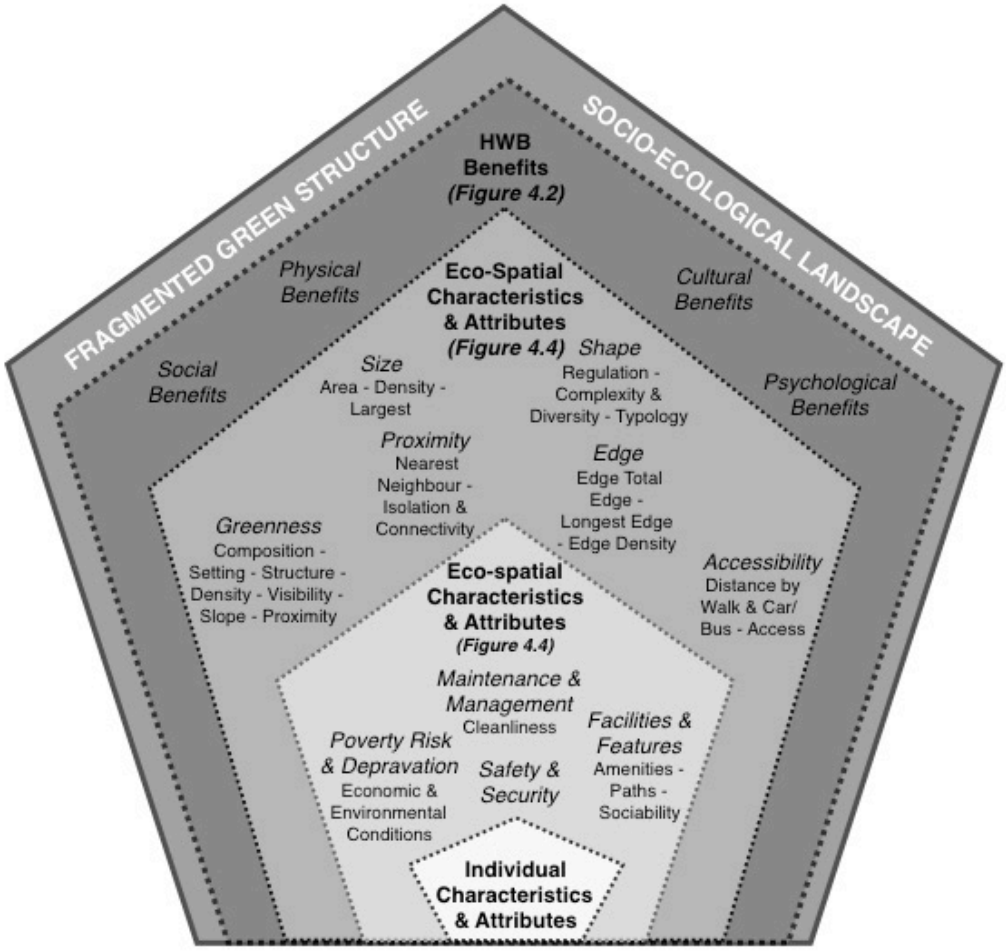


Figure 10.1
Socio-Ecological PPUIGS Characteristics integrated within the Landscape of Affordances Model

This model builds opon the Affordance Model of Figure 5.2 to illustrate the specific measurable attributes found within PPUIGS. The factors listed are those found within Figure 4.2 - Summary of HWB Benefits Received through Green Space Interaction and Figure 4.4 - PPUIGS Characteristics Performance Measurement Index.

This research operationalised a hetarchical group of eco-spatial PPUIGS indicators that (e.g. Size, Shape, Edge, Accessibility, etc – as Per Figure 10.1 and Figure 10.2), together, served as a conceptual proxy for the positive interactions specific to fragmented landscapes and GS within PolyPURs that contribute to both the ecological (i.e. ecological integrity) and socio-cultural aspects (i.e. human wellbeing) of functional landscape dynamics (See Figure 4.3 - PPUIGS Characteristics Performance Index). The PPUIGS Characteristics Performance

Measurement Index (Figure 4.4 and Table 4.4) provided a set of measurable physical attributes. By understanding the context of the PPUIGS within these transitional landscapes, PolyPURs can better manage spatial planning and design strategies to provide landscape services.

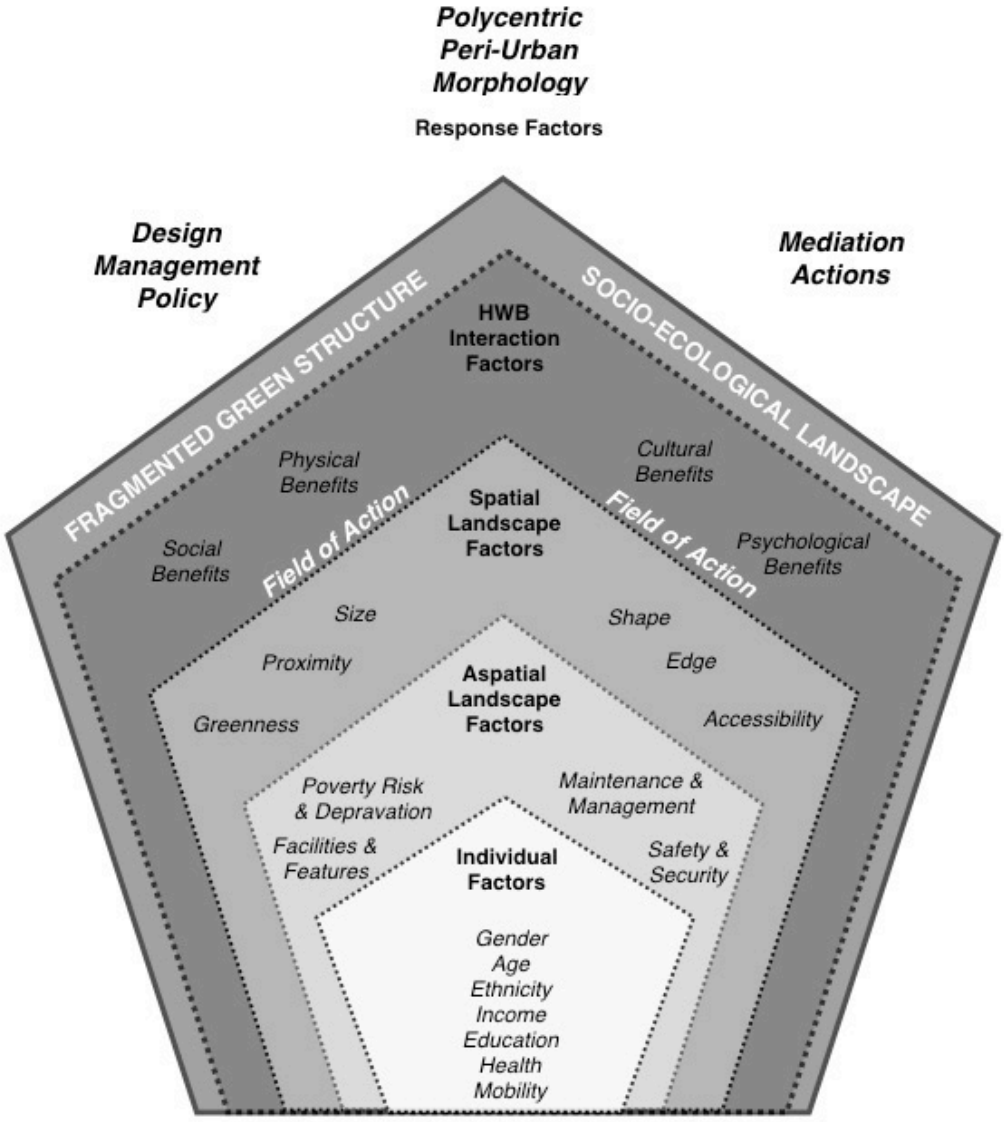


Figure 10.2
Socio-Ecological Interaction Factors
within the Landscape of Affordances Model

This model illustrates the various factors operationalized in this research.
(See Chapter 4)

The analytical strategies used in this study have brought together ecological paradigms (i.e. a natural sciences focus) and sociological perspectives (i.e. anthropocentric views and abstract relationships to 'nature') to assess these multiple factors. Overall, the comprehensive strategies employed herein provide for a mixed-method analysis focusing on the eco-spatial characteristics of the polycentric peri-urban interstitial green structures and the specific functional affordances within the case study regions and case study areas.

The analysis of the case study's physical landscape and, in particular, their GS, is comprehensive. The spatial or geographical perspectives of land cover and landscape fragmentation analysed the physical arrangement of the GS characteristics but did not include the people who interacted with them. Alternatively, the aspatial or socio-cultual persectives of the SQ and socio-economic data did not fully recognise environmental and spatio-temporal concepts. The DPSIR model, however, conceptualised current and past relationships between these two perspectives, completing a cursory analysis of GS within their individual socio-ecological landscape context. This integration of data was futher enabled by the SQ's data collection format – SoftGIS. This unique software brought together both quantitative geospatial-based and qualitative based spatial and aspatial data in order to analyse relationsips between the two - and the statistical analyses tested for the strength of relationships between this collected data.

The previous Chapters described the findings obtained from the research methodology (i.e. Case Study Analysis, Landscape Analysis, Socio-Cultural Analysis). This Chapter answers the hypothesis and the research sub-questions defined in Chapter 6. The analysis of the findings has confirmed some of the initial assumptions; but has contradicted others as well, while revealing some new findings. This Chapter's discussion takes the results from the different methods and compares them with the findings found within the literature review.

10.2 Summary of Findings

As stated within the literature review, most landscape fragmentation is damaging and undesirable for ecological systems (i.e. it has a negative impact on ecological integrity). This research has summarised the biophysical scale and

impacts of landscape fragmentation upon PURs and their IntGS, including their form, functions and processes.

The past two decades have brought suburbanisation through significant internal migration and moderate external immigration to the Helsinki region, which is now viewed as one of the fastest growing urban regions in Europe (Laakso, 2002). Yet, significantly, the various pressures of land use change and human activities upon the landscape have not affected the region's LS and QOL status. The case study area of Vantaa has a PolyPUR landscape that exists in a state of notable fragmentation and spatial heterogeneity with diversely structured GS, yet this fragmented configuration of the eco-spatial landscape analysis and results nonetheless provided multiple HWB benefits to a diverse set of residents, while maintaining a high level of LS as shown in the results.

Similarly, there has been significant landscape and land use change in the past five decades in and around Glasgow, associated with declining public health and QOL measures. Paisley's PolyPUR also exists in a notably spatially fragmented state, but there is, overall, less spatial heterogeneity and structural diversity of GS than in the Vantaa PUR. Results indicate that these Scottish residents receive most of their HWB benefits from less fragmented PUL context than those in Vantaa. Comparatively, and generally, then, it is the more fragmented landscape context of Vantaa's PPUIGS that is able to provide a more comprehensive set of HWB benefits and thus a higher sense of overall LS to its residents.

This research has shown that, overall, residents within a fragmented PoluyPUR are *not negatively affected* in their reception of multiple HWB benefits through interaction with PPUIGS in various states of fragmentation. This research further indicates multiple trends towards the likelihood of receiving a HWB benefit through interaction with a GS that exhibits the physical characteristics of landscape fragmentation.

The chosen pair of case study regions are similar in respect to all measured independent variables, except the dependent variable of interest – Life Satisfaction (Y). In this regard, the research was able to focus on the functional capacities of

their PPUIGS in order to assess their contribution to HWB and, ultimately, LS. The results have shown that a more spatially fragmented landscape whose GS exhibit eco-spatial characteristics of heterogeneity and diversity, yet with distinct aspects of overall physical interconnectivity and proximity among them, do provide a more comprehensive set of physical, social and psychological HWB benefits. This research has therefore *not supported* the hypothesis that the fragmentation of interstitial green spaces and green structures found within the polycentric peri-urban regions (PPUIGS) of Europe negatively affects the production of wellbeing benefits to humans.

10.3 Research Question 1

What are the specific spatial attributes and physical characteristics of peri-urban green spaces and green structures within a polycentric region in a fragmented state?

This question was answered though the literature review, the applied case study analysis, and by testing the results. Polycentric, peri-urban regions, and their associated GS, differ spatially and structurally from those of other urban configurations such as monocentric, polycentric, urban polycentric, functional and spatial polycentric, rural or peri-urban areas. This is primarily due to the unique patterns of urbanisation that occurred in these case study areas, and the various pressures that affected morphological growth and landscape transition, creating a spatially heterogeneous landscape pattern within diffused urban development exemplified by landscape fragmentation. Specifically, PolyPURs and their GS are affected by urbanisation on all sides, generating diverse OS and GS of various sizes and shapes among and between the regions' morphologically polycentric sub-centres. These IntGS have unique spatial and physical characteristics: they are more physically fragmented and contain more edges – particularly transitional edges – within a more diverse land cover and land use context, and a more spatially heterogeneous landscape setting, than the aforementioned configurations.

As shown in the results, including Land Cover and FRAGTATS for the GS of each CA and 10km extension, the CA's GS express more spatial fragmentation characteristics within a more urbanised context: the CA's GS had a higher patch

density, a lower shape index, and are more irregularly shaped and complex with closer proximity to other GS and, proportionally, slightly more number of edges, particularly for the most frequent GS Classes (e.g Forests and Woodlands, Grasslands and Ag).

The results of this research's case study analysis has supported, generally, the findings in the literature and added some important new evidence. These analyses showed high spatial heterogeneity and landscape fragmentation in each case study's focal region's GS. As supported within the case study analysis, specifically, the IntGS are in transition and exhibit various states and spatial characteristics of this transition from rural to urban. Compositionally, both individually and as a group, the CA's IntGS are interspersed, smaller in size, less connected, more isolated from each other, and possess more diversity in characteristics such as shape, edge conditions, and semi-natural or semi-urban vegetation, than the regional 10km counterparts. IntGS are fragmented GS primarily located on the edge of transitional landscapes, and are thus considered to embody reduced ecological integrity, reduced resilience and reduced biodiversity.

Research Finding:

Interstitial green spaces (IntGS) within polycentric peri-urban regions are transitional green spaces and are more physically fragmented, contain more edges - particularly transitional edges - and exist within a more diverse land cover and land use context, and spatially heterogeneous landscape setting, than other morphological configurations.

PPUIGS are found within and between developed parcels such as housing or industry/commercial, and are typically fragmented spatially and not connected physically to other GS (See Figure 10.7 and 10.8). As parcels develop in and around GS, the number of edges increase significantly. In Figure 10.3 and 10.4, the adjacent land uses to the Interstitial GS are diverse and many including housing of various densities, commercial, heavy and light industrial, transportation, agricultural, mining, and even diverse GS such as golf and riparian corridors. In Figure 10.5 and 10.6, the number of the PPUIGS edges over 40m in length is over 20. Edge effect impacts ecological integrity primarily negatively, reducing habitat and ecosystem functionality (Forman, 1991).



Figure 10.3
PPUIGS Spatial Characteristics – Contextual Land Uses
(Paisley, Scotland)



Figure 10.4
PPUIGS Spatial Characteristics – Contextual Land Uses
(Vantaa, Finland)

The above images show typical Interstitial GS existing in, among, between and surrounded by various land uses.



Figure 10.5
PPUIGS Spatial Characteristics – Multiple Edges
(Paisley, Scotland)



Figure 10.6
PPUIGS Spatial Characteristics - Multiple Edges
(Vantaa, Finland)

The above images show a typical Interstitial GS and its numerous edges.



Figure 10.7
PPUIGS Spatial Characteristics - Separation
(Paisley, Scotland)



Figure 10.8
PPUIGS Spatial Characteristics - Separation
(Paisley, Scotland)

The above images show typical Interstitial GS and its disconnection or physical separation from other GS.

Research Finding:

Even though the Vantaa PUR and larger HUR is more morphologically polycentric and contains more spatially fragmented GS than the Paisley PUR and GGUR, its PPUIGS exhibit distinct aspects of overall spatial connectivity and a proximal structure of physical coherence among them, thus providing a more comprehensive set of physical, social and psychological HWB benefits to its residents.

Within a more fragmented context of smaller sized, more complex and irregularly shaped GS, the Vantaa's PPUIGS still maintain a close proximity and physical connectedness to other GS (See Figure 10.9 and 10.10). As shown in Figure 10.11, 10.12, 10.13, 10.14, and 10.15, the GS are complex and diverse in shape with many sides (8+) and unique angles (e.g. 0-30deg, 110deg+) and are very small and considered smallest (<25%) in the CA.

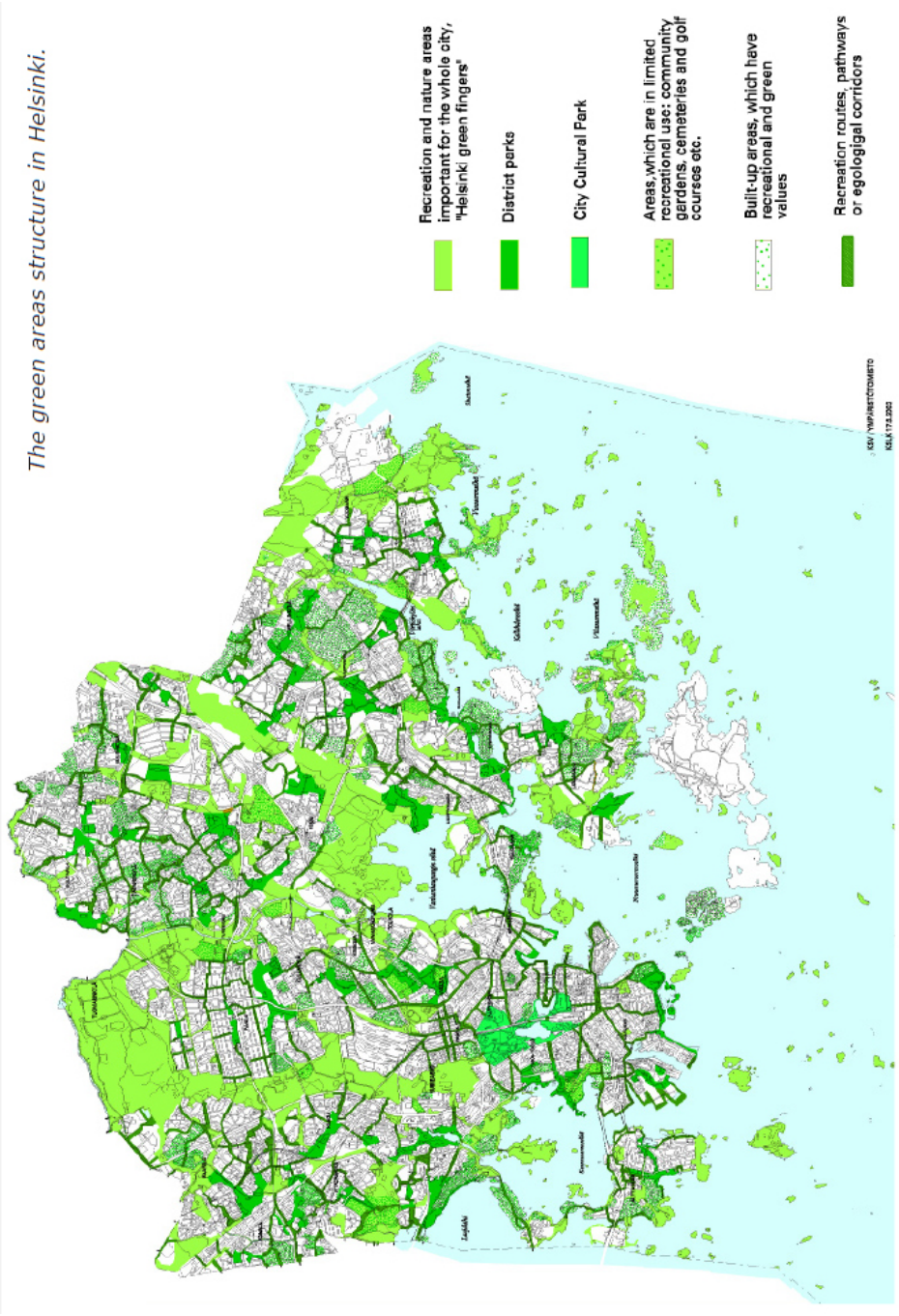


Figure 10.9
GS Spatial Characteristics of Connectivity
Helsinki Green Finger Diagram
(Helsinki Urban Region)
(Source: Group N – Climate Change Adaption Project)



Figure 10.10
GS Spatial Characteristics of Connectivity
(Helsinki Urban Region)

Within a more fragmented context of smaller sized, more complex and irregularly shaped GS, the CA's GS still maintain a close proximity and physical connectedness to other GS. This is primarily due to the Helsinki Green Finger Concept of the Region (See Figure 10.9).



Figure 10.11
GS Spatial Characteristics – Edge Diversity
(Vantaa, Finland)



Figure 10.12
GS Spatial Characteristics – Edge Complexity
(Vantaa, Finland)



Figure 10.13
GS Spatial Characteristics – Edge Shape Complexity and Diversity and Small Size
(Vantaa, Finland)

Vantaa's GS edges are considered complex with multiple sides and small in size.

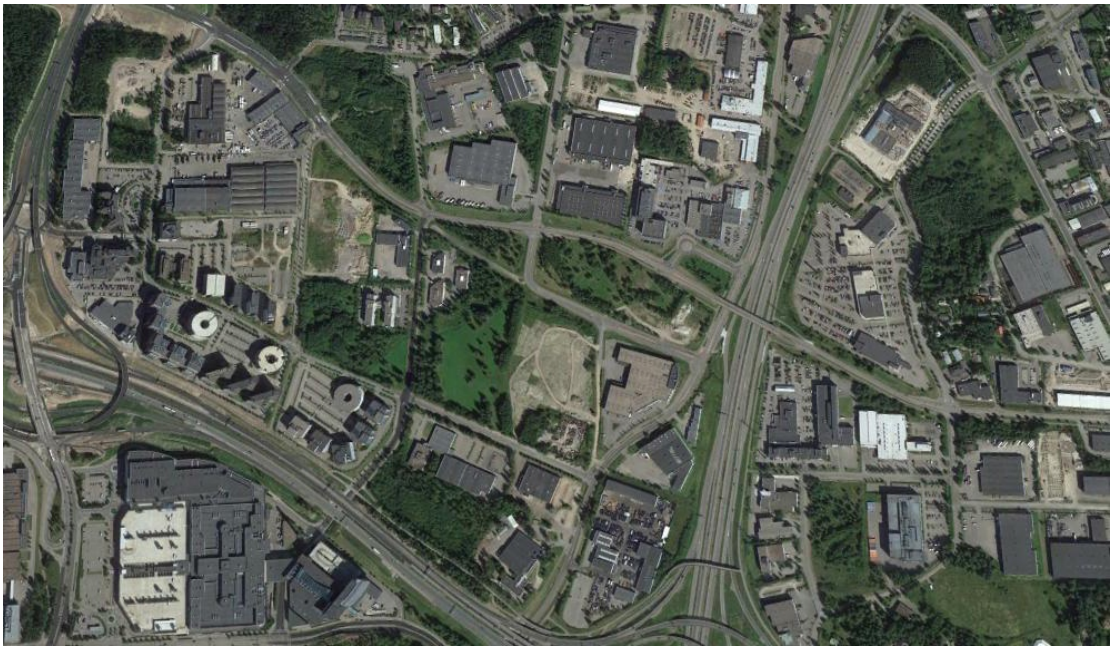


Figure 10.14
GS Spatial Characteristics - Small Size
(Vantaa, Finland)



Figure 10.15
GS Spatial Characteristics - Complex and Irregular Shapes
(Vantaa, Finland)

In summary, this research has provided spatial and non-spatial information about the quantity and qualities of landscape fragmentation characteristics within the case study areas. This research has clarified the eco-spatial context and physical characteristics of each CA and PolyPUR; specifically landscape fragmentation, spatial heterogeneity, polycentric morphology and green structure. This research has provided a coherent description and case study exploration of a unique landscape typology, PPUIGS, demonstrating notable spatial heterogeneity, edge effects and diversity within each Case Study CA's IntGS.

It should be noted that the occurrence of landscape fragmentation is not the desired insight within this research. Although most pressures and drivers of landscape fragmentation can be correlated to those of urbanisation (Section 3.2) and urban sprawl (Section 3.2.1) specific to landscape modification, landscape fragmentation is sometimes not immediately recognisable nor are its impacts quantifiable. It has been argued that urban development and the outcome of land use change through the urbanisation process actually 'completes' the landscape; filling-in the voids of the heterogeneous pattern (e.g. Informal Urbanism, UN-Habitat, 2014). It is the interconnectivity of the green space elements, the green infrastructure, within a polycentric, peri-urban, fragmented landscape context, which was of concern within this research and which is discussed in the next sections.

The landscape analysis of Paisley, Scotland, and Vantaa, Finland, provides the biophysical and spatial context in which to examine the human-nature relationship further. This research's data supports the structure-functionalist theory of the urbanisation-fragmentation relationship and provides insight into the development of a causal analysis for how PPUIGS fragmentation affects HWB. Within each region's study area, however, there exists indivual-based variability in demography, cultural settings and socio-economic influence. Overall, this research presents mostly spatially similar yet socially different case study CAs. It is these spatial relationships, and how the physical context of these PPUIGS influences human behaviour and wellbeing affordances, which is discussed in the next sections in order to answer the remaining research questions.

10.4 Research Question 2

Which are the types and what are the eco-spatial characteristics of polycentric spatially fragmented green structures that are conducive to particular human well-being affordances (e.g. psychological, social and/or physical wellbeing)?

The relationship between humans and the landscape is largely dependent upon the form and spatial qualities of the landscape. Each landscape, whether remotely rural or distinctly urban provides a diverse and unique array of physical features that in turn provide a wide variety landscape services.

As stated, few similar studies were found within the literature that analyse GS variables that exhibit commonalities to this study. This research has analysed these structural characteristics of PPUIGS at multiple scales, and although some PPUIGS exhibit more fragmentation and heterogeneous characteristics and attributes than others, they are all situated within a region of peri-urbanisation and sprawl and the PPUIGS are experiencing various levels of continued landscape fragmentation and human development pressures.

Generally, people within each CA visited certain types of PPUIGS in order to receive HWB benefits – here, predominately parks (55%) for the Paisley CA to receive psychological affordances (41%) and woodland (37%) for Vantaa CA to receive physical affordances (54%).

These frequency-based results indicate some interesting similarities and differences within the PPUIGS' structural characteristics and attributes of the CAs. For instance, respondents most frequently received a wide diversity of HWB affordances when they interacted with PPUIGS that were natural-shaped, regularly vegetated horizontally (e.g. grass), extensively sized and physically connected to another GS, or considered part of a larger group, with normal-sized edges and close to or adjacent to a heavy-trafficked road and was moderately clean and somewhat safe.

As shown in the following Figures, the GS of the Vantaa CA and Paisley CA most frequently visited with for any affordance included the following characterstics and levels and are described in detail following:

- Extensive Size;
- Natural Shape;
- Physically Connected to another GS;
- GS is considered part of another GS or larger group of GS;
- Uniform Horizontal Vegetation;
- Normal Size Edges;
- Close or Adjacent to Heavily Trafficked Roads;
- Moderately Clean;
- Somewhat Safe.

These GS were extensive in size meaning these GS separate houses well; where you can not see other houses within GS or at GS edge (See Figure 10.16).



Figure 10.16
GS Spatial Characteristic of Extensive Size
(Vantaa, Finland)

These GS were natural in shape and level of greenness. This means the GS, regardless of facilities or amenities including paths, lights, bins, benches, and toilets was considered natural, not urban, which felt wild and natural or had a sense of ruralness to it. These GS had no informal recreation opportunities (beyond trail walking, wildlife viewing, etc), a wide variety of vegetation types and/or types of habitats and with predominately natural or naturalistic vegetation. Overall, these GS lacked a formal composition and had a 'wild' feeling to it, often woodlands or wild, unmanaged spaces (See Figure 10.17).



Figure 10.17
GS Spatial Characteristic of Naturalness
(Paisley, Scotland – Pollock Park)

These GS were very close in proximity to another GS – they were physically connected to another GS on at least one side with no street or wall or fence. This means the GS is part of a larger green structure or group of interconnected GS within the CA and neighbourhood (See Figure 10.18).



Figure 10.18
GS Spatial Characteristic of Physical Connectedness
(Vantaa, Finland – Kaloopeski Beach Park)

In this image, the beach park is physically connected to the forested GS (rear of image) and also to a more formal playfield (behind, not shown) and linear corridor pathway (not shown).

These GS were not isolated, they were considered, when viewed without land ownership boundaries but spatially, one in a group of many GS nearby. For instance, a soccer playfield is often considered part of a larger regional park with a variety of amenities and features of diverse GS such as a fishing pond, community garden and/or children's playground (See Figure 10.19).



Figure 10.19
GS Spatial Characteristic of Interconnectivity and Grouped GS
(Paisley, Scotland – Pollock Park)

In this image of Pollock Park, there are many diverse yet physically interconnected GS such as a playfield, botanical gardens, cricket field, golf course (far left), formal allee garden, conservatory, woodland, and others, yet all considered part of the larger Pollock Park.

These GS included the horizontal vegetation structure characteristic that was considered uniform – meaning the GS had hardly any different horizontal vegetation types (e.g. play fields, mown grass – not diverse vegetation types or structure) (See Figure 10.20).



Figure 10.20
GS Spatial Characteristic of Uniform Horizontal Vegetation Structure
(Vantaa, Finland – GS near Fastholma)

These GS also included those with moderate sized edges – meaning the longest edge of the GS, regardless of number of edges, was considered typical or moderate when compared to larger or smaller sized edges of other GS within the GS (See Figure 10.21).



Figure 10.21
GS Spatial Characteristic of Moderate Edge Size
(Paisley Scotland – GS near Foxbar)

In this image of GS near Foxbar, Scotland, the GS, generally as shown here, have consistent and moderate sized or lengthed edges with none being noticeably larger or smaller than the others.

These GS are most often near to or directly adjacent to a heavily trafficked road such as an M-Road, A-Road or 4-land Road (See Figure 10.22).



Figure 10.22
GS Spatial Characteristic of Roadway Adjacency
(Vantaa, Finland)

These GS are most often considered Moderately Clean and Somewhat Safe. In this regard, the GS are maintained and managed to a level considered adequate - with some cracking to the pavement, grass is mowed frequently but not consistently, there may be some dog fouling here and there and a few small areas of graffiti and rubbish having fallen outside the bins. If there are structures or facilities such as benches or bathrooms, they are adequately maintained and clean. Some benches may be broken or unstable and there may be open dirt areas where the grass is not properly maintained. Safety wise, these GS are considered somewhat safe – not unsafe yet not safe. These GS do have the presence of lighting, locked gates, open edges, visibility/eyes-on, and even management; however, some edges are open and visibility is only acceptable at some places. There may be a few areas with minimal lights and areas with enclosed or dark edges which inhibit visibility (See Figure 10.23).

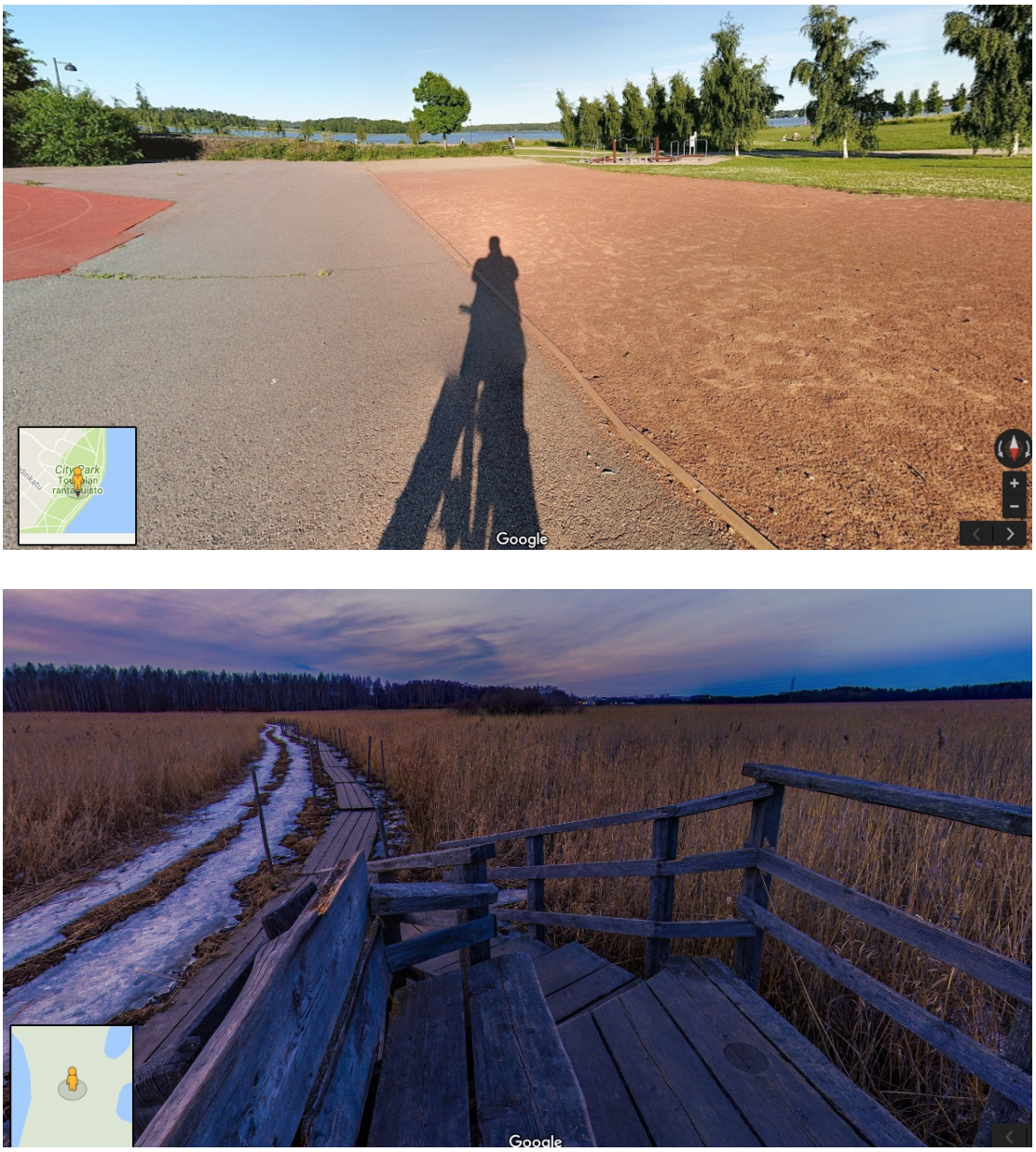


Figure 10.23
GS Spatial Characteristic of Moderately Clean and Somewhat Safe
(Vantaa, Finland)

Overall, all these characteristics promote multiple HWB affordances through accessibility, safety, sociability, and the cognitive aspects of coherence, complexity (variety and diversity), reduction of visual stress, legibility and separation from urban and anthropocentric elements (See Chapter 4). Ecologically these same GS characteristics provide high ecological functioning through ecological patch dynamics and biodiversity thru its configuration of spatial heterogeneity, edge dynamics, aggregation, and richness including composition and diversity (See Chapter 7 and Table 4.3).

Overall, when considering the group of those stastically significant PPUIGS cahracteristics, attributes and levels – there are distinct similarities for both case studies. For both, psychological HWB affordances are more likely to be received from less fragmented PPUIGs whereas social and physical HWB affordances are correlated to more fragmented PPUIGS.

However, there were no statistically significant PPUIGS characteristics and attributes shared between the PPUIGS of the case study regions and the any of three HWB affordances. Yet statistically significant trend results indicate respondents for both CAs received psychological HWB affordances from naturalistic and physically connected PPUIGS, social HWB affordances from PPUGS with edge effects, and physical HWB affordances from linear shaped GS.

As shown in Figure 10.24 and Figure 10.24, both a plan view and section view, the GS of both the Paisley CA and the Vantaa CA have a statistical trend tendency to provide Psychological HWB affordances through their GS characteristics of naturalistic shape to it whereas its most dominant spatial GS portion feels wild and natural and has a sense of ruralness to it; it does not feel urban such as a civic monument park or urban parklet with many facilities and features. Additionally, these GS are physically connected on at least one side to another GS, though not of the same ownership, management or even typology. This connection or nearest neighbour did not include a fence, wall or street – it is visually and physically connected creating a larger green structure to the Regions.

They psychological affordances are provided primarily through the cognitive aspects of coherence, legibility, reduction of visual stress, appropriateness, and sense of naturalness and complexity (See Chapter 4). Ecologically these same GS characteristics provide high ecological functioning through ecological patch dynamics and biodiversity including composition, richness and diversity (See Chapter 7 and Table 4.3).



Figure 10.24
Naturalistic and Physically Connected GS provide Psychological HWB Affordances
(Vantaa, Finland)





Figure 10.25

Naturalistic and Physically Connected GS provide Psychological HWB Affordances
(Paisley, Scotland – Barshaw Park)

As shown in Figure 10.26 and Figure 10.27, both a plan view and section view, the GS of the Vantaa CA and Paisley CA have a statistical trend tendency to provide Social HWB affordances through their specific GS edge characteristics. Specifically, these GS edges are numerous or include 8 or more distinct edges over 40m in length, and their edge condition – that of vegetation (trees, shrubs) and/or

built structures (fence, wall, houses, etc), is moderate (i.e. not dense or not open), meaning some edge areas offer visibility into and out of the GS. Lastly, these GS edges are of moderate and short lengths when compared to other GS edges in the CA.

The social affordances are provided primarily through the cognitive aspects of coherence and visual quality, legibility, as well as specific aspects of edges such as separation & distinctness and the GS relationship to surroundings to provide safety, legibility and visibility, and opportunities of access and benefits (See Chapter 4). Ecologically these same GS characteristics provide high ecological functioning through ecological patch dynamics and biodiversity through edge effects including composition, richness and diversity (See Chapter 7 and Table 4.3).



Figure 10.26
GS Edges provide Social HWB Affordances
(Vantaa, Finland)



Figure 10.27
GS Edges provide Social HWB Affordances
(Paisley, Scotland)

As shown in Figure 10.81 and Figure 10.29, both a plan view and section view, the GS of the Vantaa CA and Paisley CA have a statistical trend tendency to provide Physical HWB affordances through their GS characteristics of linear shape where the GS is considered a linear corridor such as a bike/ski path or river walkway with a few larger areas (e.g. parking areas and amenities such as benches, bathrooms, etc.) along the linear route. It is distinctly linear in shape with some of or the longest edges in the CA.

They physical affordances are provided primarily through the behavioural aspects of physical activity but also the cognitive aspects of coherence, complexity or variety and diversity, and a sense of naturalness which reduces visual stress (See Chapter 4). Ecologically these same GS characteristics provide high ecological functioning through ecological patch dynamics and biodiversity thru its configuration of spatial heterogeneity, edge dynamics, and richness including composition, richness and diversity (See Chapter 7 and Table 4.3).

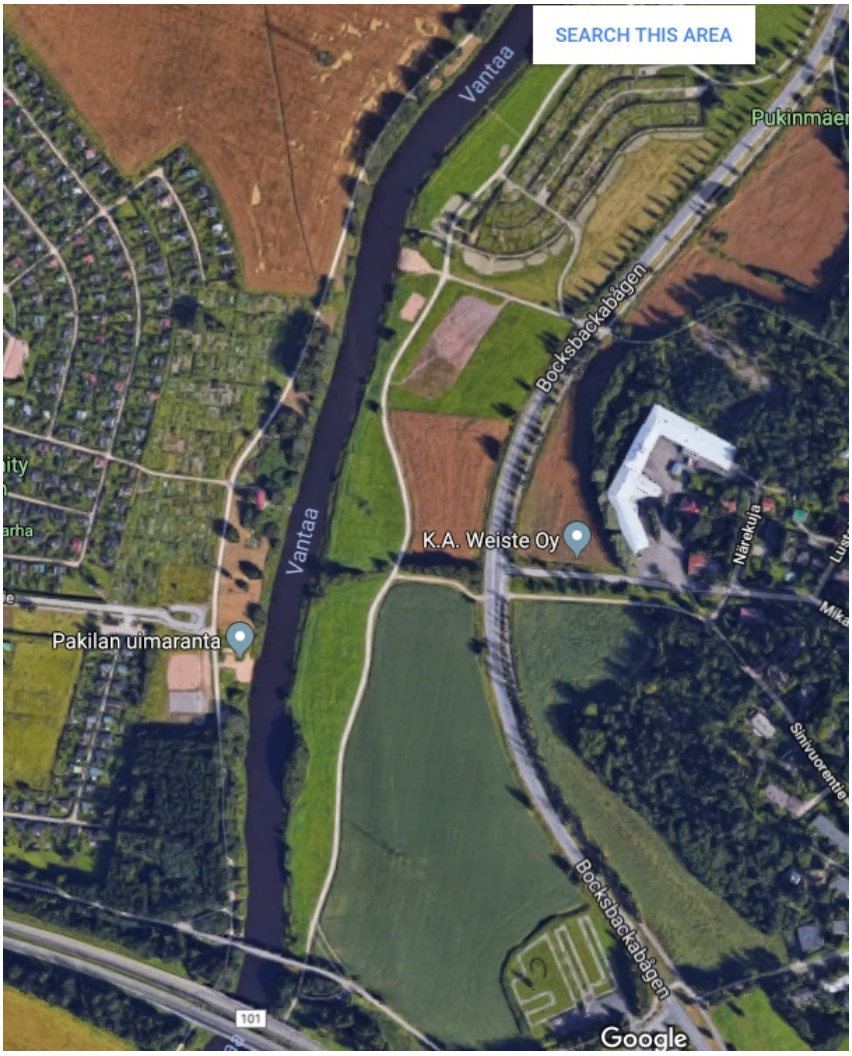




Figure 10.28
Linear Shaped GS provide Physical HWB Affordances
(Vantaa, Finland)



Figure 10.29
Linear Shaped GS provide Physical HWB Affordances
(Paisley, Scotland)

In summary, all of the qualities and characteristics found within fragmented PPUIGS were incorporated to the best degree possible within the structural and functional characteristics and attributes selected. Overall, many of the structural factors and the wellbeing attributes overlap one another and, to the best degree possible, were incorporated into the most appropriate characteristic so as to reduce redundancy. Again, it was impossible to capture all experiential qualities of HWB affordances received from PPUIGS within a contemporary socio-ecological landscape. Thus, this system of attributes to encapsulate these benefits of PPUIGS was enacted to effectively capture these constructs.

10.5 Research Question 3

What types of people use what types of polycentric green spaces and green structures for what types of human wellbeing benefits?

In order to answer the first part of this question, *"What types of people use what types of polycentric interstitial green spaces and green structures"*, the results of the demographic and socio-economic data found within the individual factors will be discussed. The secondary data's socio-economic data were considered unreliable and removed from data analysis except within descriptive analyses prior. The only socio-demographic independent variables (X2) to remain within the further statistical analyses were gender and age. It is determined that the samples within this research are representative of the larger population within each region.

The secondary data, as collected by post-code inference, is considered statistically weak since it does not provide information specific to those respondents, only the postal code region in which they reside. The data does provide some generalised information that gives insights into the relationship, however. For example, the results illustrate that, overall, there is lower economic hardship and deprivation within Finland than in Scotland. For instance, no respondent in the Vantaa CA was correlated to an income level below poverty, whereas in the Paisley CA, 15 respondents or 28% live within a geographical zone considered to have less than 30% of Scotland's combined SIMD threshold levels, and 20% of Paisley CA respondents have an average household income below 5000

GBP. This was somewhat expected as Nordic countries are considered more stable economically in regards to wealth distribution. Paisley, Scotland and the UK experienced a notable increase in poverty during the early 1980's, which is almost twice that of the Nordic countries (Korpi and Palme, 2004).

Currently (2016) there is no official single way of measuring and defining relative poverty in the international context, though poverty threshold is most common. In terms of cross-national comparisons, the limitation of relative income measurements of deprivation is that they indicate only relative differences inside of a nation and do not tell anything about the differences between nations in absolute terms.

Accessibility to GS is a key topic in the literature on deprived communities. Although this research does provide some basic metrics and analysis for these accessibility variables, further study could be completed with this research's metadata that could prove valuable to such concerns. For instance, seven respondents in the Paisley CA were identified as living within deprived communities (i.e. in the lowest depravity quintile ranking of 0-10% and a SIMD rank <15%) and their particular nearest GS had an average distance of 0-400 m (n=4) and 400-800 m (n=3). Of these seven respondents, only three visited the nearest GS (FGS and OGS). Thus, deprivation does not strongly indicate nearest GS visitation.

In addition to the various demographic and socio-economic data, this research collected data on the respondents' self-reported levels of life satisfaction. Within the Paisley CA, 67% of respondents reported a LS level of satisfied or highly satisfied; within the Vantaa CA, this was 77%. More than twice the percentage (13%) of respondents in the Paisley CA, meanwhile, reported unsatisfied or highly unsatisfied LS compared to the Vantaa CA (6%).

Together, these two sets of results begin to describe the respondents of the SQ better. In both samples, males reported lower LS than females. Interestingly, within the Vantaa CA, it was the moderate level of income group, 30 – 40K, which reported both the highest percentages of LS as well as the lowest, indicating this economic group was less stable in LS rankings than others.

These results seem to indicate that a higher level of income does not neccessarily result in a higher self-reported LS ranking. Interestingly, lower household income respondents, overall, percentage-wise, reported fewer lower LS rankings than the higher income respondents. Additionally, of the respondents, 20% of those aged 45-54 reported a low LS ranking, indicating, across CAs, that this age is a potential marker for low LS.

Although this research indicates no statistically significant demographic or individual factors that influence GS interaction, it does support other research that has suggested possible differences on the basis of age, gender and ethnicity (Ward Thompson et al., 2004; Payne et al., 2002; Gobster et al., 2002). Interestingly, in Helsinki, Finland, Makinen and Tyrvainen explored more general differences between boys and girls suggesting that boys looked more at opportunities for activities in GS and used them more than girls (2009).

In order to answer the second part of this question *"… for what types of human wellbeing benefits?"*, these next paragraphs will discuss the relationships and patterns of interaction found within the statistical analyses. It is important to note, however, that none of the relationships were reported as statistically significant through factor analysis (Pearson Chi-Square, 2-Sided, $p.<0.05$).

Reviewing these results, interesting patterns emerge between and among the CAs. Milligan, Gatrell and Bingley (2004) found that older UK respondents stated the benefits of gardening on allotments, including a sense of achievement and satisfaction, as well as noting the importance of social networks and reduction in social isolation provided by communal gardening. This result is supported by Kweon et al. (1998) who found that exposure to GS was associated with higher levels of social integration and a greater sense of local community for older people. Results of this research partially support these findings: within the Vantaa CA, respondents aged 65-75 visited PPUIGS for physical HWB affordances (n=3, 100%) whereas in the Paisley CA respondents of the same age visited PPUIGS for psychological HWB affordances (n=8, 57%). Social HWB benefits, however, were the least common affordance noted in both CA samples for the Community Garden and Allotment GS typology.

10.6 Research Question 4

What type of peri-urban green space assemblages provide the most affordances to human wellbeing measures?

The literature has provided copious evidence that GS positively affects HWB, though it does not clearly outline the specific mechanisms or processes that underlie the relationship (e.g., Korpela et al., 2014; Maas et al., 2008), and even less so for those specific to fragmented PPUIGS. Identifying and understanding these mechanisms is important to help understand potential drivers of this relationship, and how future mediations are possible.

Recent research by urban researchers such as Seymour and colleagues (2010), Ghosh and Head (2009) and Guitart et al. (2012) has noted that urbanisation is placing pressure on the ability of formal GS systems to meet residents' wellbeing needs. Scholars and practitioners have begun to turn their attention to forgotten or leftover urban spaces to better understand what functions they perform and how they might meet the needs of diverse urban populations (Pyle, 2002; Campo, 2013).

The literature has suggested that physical contact with GS influences HWB by providing psychological restoration, physical interaction and social opportunities, among many others. This research supports such findings by showing that interaction with GS supports overall HWB. Within this research's heterogeneous spatial context, however, the many smaller, complex, diverse shaped, interstitial, multiple edged, and less coherent GS are, overall, distributed unevenly within the PUL. This aspect influences accessibility, and thereby, hypothetically, the ability to receive HWB benefits through interaction. HWB benefits are still achieved thorough interaction with these PPUIGS within the larger PolyPUR structure, however; although some HWB benefits are potentially not achieved through interaction with other GS in different contexts such as those specific to primarily urban or rural spatialities.

Within the study's CAs, a variety of green structures and green spaces exist. This study chose not to provide a typological, keyed map or listing of GS within the CA. Rather, this study's strength is found within allowing the survey participants to identify the GS they utilise to receive an affordance. This provided a greater

diversity of GS to be analysed, many not defined by traditional municipal-based administrative boundaries (e.g. Pollock Park, Kaisaniemi Park) or GIS-based land-use and other land-ownership boundaries (e.g. Agricultural Areas, Johnstone Hospital, Barbush Farm). This section discusses the most prominent GS assemblages or groupings of PPUIGS eco-spatial characteristics as noted within the results and compared to the literature.

10.6.1 Woodlands/Forests Assemblages

Both forests and woodlands are significant land cover components of the two CAs' spatial landscape and provide a series of landscape services (e.g. Coles and Bussery, 2001). In the Paisley CA, parks were the most visited GS typology and woodlands were the third most interacted GS. The parks within the Paisley CA were, however, often large and contained woodlands as a GS element within them. In the Vantaa CA, forests were the most visited GS. These results are supported by Hietala et al. (2013) who studied the Vantaa peri-urban region and 'fringe zone' and reported that in a survey, 86% of respondents stated that the three most pleasant green spaces were forests, parks and farming land.

Forests and woodlands in both CAs provided, in terms of frequency, primarily physical HWB benefits, followed by psychological benefits then, lastly, social HWB benefits. This result reflects the study by Macnaghten and Urry (2000) focussing on UK woodland interaction where individuals conducted specific outdoor recreation activities such as mountain biking and rock climbing but also reported the intention of *"being in contact with nature"* and walking. This result was not clearly echoed in research by Chiesura (2002), however, where local woods were appreciated for *"the human experiences and social relationships that such spaces afford"*. These studies are not fully applicable to this study as 'local' woods were not explicitly identified and the concept of synergistic-benefits, i.e. both social and physical HWB benefits from the same woodland interaction, was not accounted for.

It the Paisley study, 70% (n=7) of the woodland PPUIGS were considered extensive in size, meaning they separated housing or built structures, but only 10% of the woodlands interacted in were within 400m of their home location. In the

Vantaa study, meanwhile, 84% (n=38) of the woodland PPUIGS were considered extensive in size, but only 9% of the woodlands were within 400m of their home location, suggesting that these respondents will travel some distance to interact with woodlands. These results are supported by Hilldson et al.'s (2007) study, where GS smaller than two hectares were not visited. Previous research has suggested that larger forested areas outside the urban core were important for weekend recreation, but the smaller local spaces in the city centre were more important for everyday life (Van Herzele and Wiedermann, 2003), however this research cannot support that finding as most "Nearest GS" visited were not considered small in size. There are many reasons for this, including the limited number of GS identifications made in the data collection, thereby precluding interactions with other unrecorded GS, such as these smaller, nearby, GS.

Within this research, the selected Paisley woodland PPUIGS were characterised in respect to their maintenance as clean (47%), moderately clean (47%) and dirty (6%). They were also inadequately provided with facilities (89%) such as rubbish bins, benches, bathrooms; predominately containing unpaved paths (89%); and were considered somewhat safe (84%) (See Figure 10.30). Within the Vantaa CA, woodlands were characterised in respect to their maintenance as moderately clean (90%). They were also inadequately provided with facilities (58%); predominately containing unpaved paths (80%); and were considered somewhat safe (57%) (See Figure 10.31). Thus, Vantaa, CA's woodlands are considered more clean in regards to Maintenance and Management and the characteristics of trimmed vegetation or mowed grass with few exposed dirt areas and minimal dog fouling, graffiitti and whose rubbish bins do not contain overflowing or fallen trash than those within the Paisley CA.



Figure 10.30
Woodland GS were most frequently Clean with Inadequate Facilities, Unpaved Paths, and Somewhat Safe
(Paisley, Scotland – Rannoch Woodlands)



Figure 10.31
Woodland GS were most frequently Moderately Clean with Inadequate Facilities, Unpaved Paths, and Somewhat Safe (Vantaa, Finland)

Within the Helsinki CA's forests and the Paisley CA's parks PPUIGS typologies, these were interacted with for all HWB benefits. Furthermore, both of these typologies were also clearly illustrative of fragmentation and heterogeneous morphological characteristics within their PPUIGS and larger PURs. For instance, in Finland, forests and meadows are often located at the urban fringe or between districts of city boundaries (Bell et al., 2005; Hirvensalo, 2006). Additionally, the Vantaa CA's forests included numerously edged, mixed vegetation and natural

vegetation characteristics (See Figure 10.32), as would be expected given that the land cover analysis showed many smaller sized forests spread throughout the region in a diffused pattern (See Figure 10.33)





Figure 10.32
Woodland and Forest GS were multiple edged with a mixed and naturalistic vegetation structure.
(Vantaa, Finland – Paoelhina Woodlands)

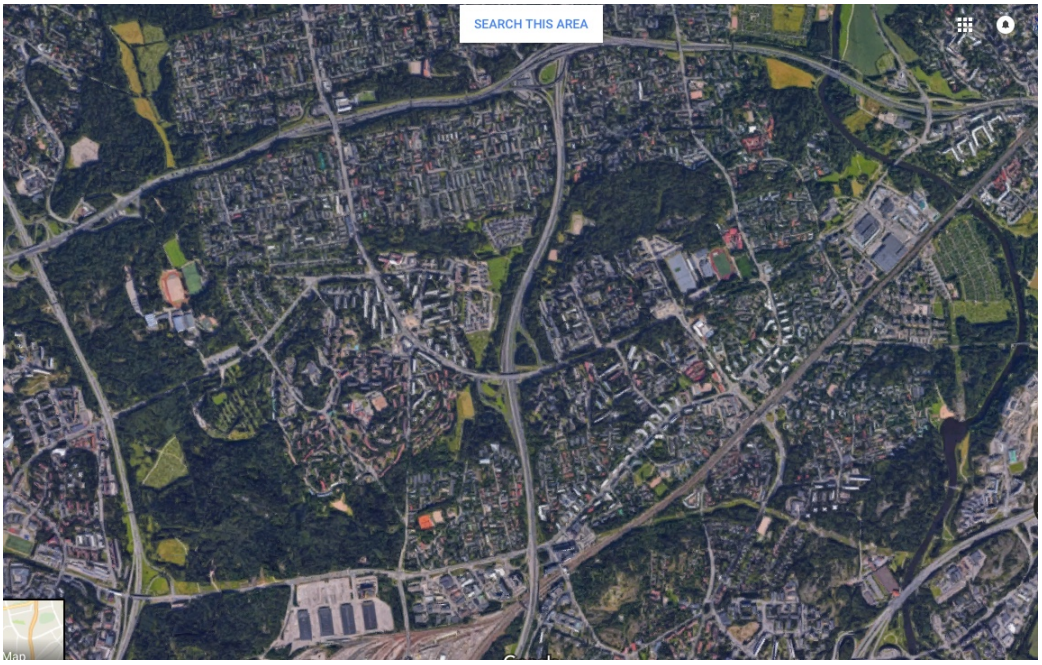


Figure 10.33
Woodland and Forest GS were spatially smaller in size and were a more frequent GS typology than the Paisley CA.
(Vantaa, Finland)

Cultural attributes are an important influence on the interaction with and affordances from GS, and many studies have linked cultural landscapes to HWB, but defining a cultural landscape is difficult and contextual. This research did not determine the cultural aspects of PPUIGS characteristics found within these distinct PULs; rather it focused on the descriptive, physical characteristics in order to deconstruct their ecological and HWB functional capacities. Overall, the PPUIGS and green structure within the Paisley CA and PUR is, overall, more anthropocised than the Vantaa CA. An example of cultural influence, for instance, is that the Scottish may prefer or demand less natural GS with higher levels of maintenance and management, just as the Finns may prefer weekend trips to forest cabins in the north of the country. The results from other studies (Duhme and Pauleit, 1992; Pauleit and Duhme, 1995, 2000; McPherson, 1998; Scott et al., 1998; Nowak et al., 2002) clearly show the role of mature stands of large trees for climate improvements, reduction of surface run-off and to support biodiversity.

Another example of potential cultural influences on the reception of HWB benefits is again exemplified by woodlands and forests. Forest restoration is practiced in Europe often under the moniker of 'forest landscape restoration' (FLR) and is defined as a "*planned process to regain ecological integrity and enhance human well-being in deforested or degraded landscapes*" (Mansourian et al., 2005). FLR recognizes that forest restoration has social and economic functions; it aims to achieve the best possible compromise between meeting both conservation goals and human needs, often economic. As human development pressure on landscapes increases, forest restoration and other landscape management practices will evolve within Europe.

Overall, results illustrate that vegetation characteristics within PPUIGS provide important HWB benefits. This is supported by research. Jorgensen, Hitchmough and Calvert (2002) examined the relationship between spatial arrangement and vegetation structure utilising a picture-based survey of residents in Sheffield, UK. They found that more open woodlands were considered safer then closed ones, that whereas sparser vegetation is preferred in close views, denser

vegetation is preferred when viewed from a distance, and that naturalistic shrubby edge treatments were considered unsafe relative to less dense treatments.

This research indicates possible management strategies for woodlands and forests in PPUIGS, but an interesting question remains: why don't people visit woodlands and forests in the Paisley CA as much as in Vantaa CA? Beyond typological identification and land cover metrics, there are many potential reasons. In addition to aspects of safety and security and human variability, as discussed, Ward-Thompson et al. (2005) suggested that childhood visits led to adulthood visitation of woodlands. In that regard, it can be observed that forests are considered a deep-rooted part of the mental attitude and cultural identity of Finland; the experience of 'Forest Bathing' is seen as a significant cultural human-nature interaction and forest visitation often occurs at an early age. Additionally, as discussed, greenery within urbanising settlements is common within the Vantaa PUR. In a study of Vantaa's urban fringe areas, Hietala et al. showed that the value of this greenstructure to residents has led to the dispersed settlement structures and fragmented GS within the Vantaa CA (2013). In Finland and the HUR, most of the urban growth is located on previously unbuilt areas, most often forest rather than agricultural areas, since the latter are typically privately owned.

10.6.2 Edge and Edge Conditions within GS Assemblages

The edge-effect impacts from human-induced modifications vary according to the spatio-temporal context (Tscharntke et al., 2012) and include variables such as landscape conditions, type and age of impact, matrix type, influence of pollution/soil/water and type of anthropogenic interference (Hardt et al., 2013). This research has shown that edges are a significant spatial component of polycentric, peri-urban regions and their green spaces. In this unique context, the eco-spatial characteristics of edges provide a set of important benefits to humans, particularly HWB.

Through the process of urbanisation and spatial fragmentation, the morphological concept of edges serves to define these PolyPURs landscape, particularly when viewed from the integrated socio-ecological perspective. Studies have acknowledged their ecological importance (e.g. Forman, 1986) within larger

ecotones, as well as their social significance (e.g. Appleton, 1975; Franck and Stevens, 2007). Far fewer studies, however, have focused on the physical edges of GS within PULs and their contribution to HWB. The morphological context of these edges has led to them being described as ‘transitional edges’ (Thwaites and Simkins, 2007) which recognizes their spatio-temporality. As argued by Thwaites (2013), transitional edges are comprehensible, eco-spatial constructs, not simply boundaries between spaces (e.g. urban sociology or ‘territories’). This research has shown the functional significance of these PPUIGS transitional edges, as well as their varied eco-spatial characteristics and attributes, including notable differences in edge densities and corresponding HWB benefit affordances, revealing that those PPUIGS with between four and eight edges were the most widely interacted with for social affordances (See Figure 10.34).



Figure 10.34
Edge Characteristics of GS with 4-8 Edges provide Social Affordances
(Vantaa, Finland – top and Paisley, Scotland - bottom)

Additionally, results show that respondents and their unique HWB affordances are sensitive to the density of edges within those PPUIGS. The density of edges (transparent vs. opaque) (See Figure 10.35) and vegetation structure (dense and clustered vs. open and random) (See Figure 10.36) was shown to be influential in HWB affordances in both PUR's PPUIGS.



Figure 10.35
Edge Characteristics of GS – Edge Density
(Vantaa, Finland – transparent, top and Paisley, Scotland – opaque, bottom)





Figure 10.36
Edge Characteristics of GS – Edge Vegetation Structure
(Vantaa, Finland – dense and clustered, top and Paisley, Scotland – open and random, bottom)

Within this research's statistical analysis, there were only two (2) GS Characterisics which returned a different highest frequency ranking for each of the three (3) different measurement levels: Edge Density and Vegetation Structure Density. This result simply illustrates that different edge conditions, both vegetative and otherwise, are, generally, shown to facilitate different HWB affordances more clearly than other GS Characteristics (See Table 9.6).

For the Paisley CA GS, the Density of their Edges correlated to different HWB affordances. In this characteristic, the edge condition can be vegetation (trees, shrubs) and/or built structures (fence, wall, houses, etc). For both groups of respondents, Physical affordances were most positively influenced (45% of all responses) by moderate edge density, meaning only some these GS edges offered visibility into and out of the GS (See Figure 10.37). For Social affordances, these GS edges were most positively influenced (40% of all responses) by very dense edges, where there was limited visibility into and out of the GS and these edges often blocked these views (See Figure 10.38). Psychological affordances were most positively influenced (37% of responses) by transparent edges or very open edges of the GS in which the open edges made visibility easy both into and out of the GS (See Figure 10.39). Additionaly, only the Extensive Edge level showed statistical significance ($p=0.021$) for social HWB affordances.



Figure 10.37
Influential GS Characteristics – Moderate Edge Density influences Physical Affordances
(Paisley, Scotland – Barshaw Park)



Figure 10.38
Influential GS Characteristics – Extensive Edge Density influences Social Affordances
(Paisley, Scotland – Pollock Park)



Figure 10.39
Influential GS Characteristics – Transparent Edge Density influences Psychological Affordances
(Paisley, Scotland – Robertson Park)

Additionally, for the Vantaa CA's GS, the Vegetative Density of their Edges correlated to different HWB affordances. In this characteristic, the Vegetation condition, whether Deciduous, Mixed and Coniferous Vegetation, Horizontally and Vertically, when Considered Spatially, creates a Vegetation Density. For both groups of respondents, Physical affordances were most positively influenced (46% of all responses) by a Dense vegetation density, meaning within the GS there are many dense or clustered plantings, crowded and tightly-packed (See Figure 10.40). Social affordances were most positively influenced (39% of all responses) by Open vegetation density where the GS included sparse plantings or few plantings overall and is considered open and spacious (e.g. mostly grass areas, play fields) (See Figure 10.41). Psychological affordances were most positively influenced (38% of all responses) by Moderate vegetation density where there is both open or sparse plantings and dense planting areas – a mixture of open areas and more densely planted areas (See Figure 10.42). Additionaly, all three (3) of these levels showed a trend toward statistical significance with the Characteristics of Open Vegetation Structure Density existing as a significant factor ($p=0.006$) for social HWB affordances.



Figure 10.40
Influential GS Characteristics – Dense Vegetation influences Physical Affordances
(Vantaa, Finland)



Figure 10.41
Influential GS Characteristics – Open Vegetation influences Social Affordances
(Vantaa, Finland)



Figure 10.42
Influential GS Characteristics – Moderate Vegetation influences Psychological Affordances
(Vantaa, Finland)

Limitations exist within socio-ecological landscape research and edge effects. Most of the literature focuses on forested landscapes (e.g. Wuyts et al., 2008) and no clear metric exists for the distance of the fragmentation/edge-effect impact (i.e. the penetration depth: 20m vs. 150m) (Spangenberg and Kölling, 2004). Further limiting effective study, Ries et al. (2004) note that many researchers have failed to constructively comprehend how the surrounding landscape contributes to the formation and impact of edges. Studies have also produced varying edge contrast measures (i.e. a measure of the difference in structure, function or composition between the forest and the adjacent land use (Cadenasso et al., 2003). The cumulative effect of edges is also not well understood (Fletcher, 2005).

10.6.3 Accessible GS Assemblages

Accessibility as a concept associated with GS is defined as a level of the spatial nearness or proximity of one place to another. Much of the literature explores the importance of access to GS as a means to study public health, equity and HWB (e.g. Schipperijn et al., 2010). Specifically, accessibility to GS provides HWB benefits such as better physical and mental health (Maas et al., 2009, Townsend 2006, Ulrich 1984), greater community cohesion (Coley et al., 1997,

Kuo et al., 1998), and decreased crime (Kuo and Sullivan, 1998) among many other benefits.

When viewing the case study areas' PPUIGS, both regions possess a distinctly dominant natural land cover type or green structure typology: for the HUR it is forest and for the GGUR it is grassland. Furthermore, unlike other countries, such as the United States, a significant proportion of the regional GS are publicly accessible.

Within each case study region, different nomenclatures exist, often for similar PPUIGS elements or characteristics. For example, in Scotland and the UK, 'woodlands' are the term for Finland and Scandinavia's 'forests'. Both regions have these typologies present, and though some are in private ownership, most if not all permit public access, particularly through Finland's 'everyman's right' (*"jokamiehenoikeus"* in Finnish) and Scotland's 'freedom to roam' universal access policy.

This research did not focus on distance, mobility, and/or accessibility to GS, a common attribute found within much of the literature (e.g. Oh and Jeong, 2007; Van Herzele and Wiedemann, 2003) but the data collected provides for interesting relational insight.

For example, these results support the overall spatially heterogeneous and fragmented morphologies for each PUR. The Vantaa CA is less fragmented, thus limiting nearby GS interaction, whereas the Paisley CA, overall, contains more spatially fragmented GS, providing more accessible opportunities. This would suggest that the results should indicate more nearby GS visits for the Paisley CA, but this did not occur. There are many reasons for this. First, the backyard garden is a common physical component of UK and Scottish homes. It is likely that these GS provided a measure of PPUIGS interaction and HWB benefits, thereby allowing visits to other, more distant GS to achieve a different benefit within a different, less-urban, environment. This research did not coordinate what particular HWB affordance was afforded within the nearest GS, however; only whether it was visited or not.

Overall, proximity to GS was not a significant predictor of GS interaction within this study. This contradicts other studies where proximity was found to be particularly important in predicting visitation of GS (Ward Thompson, 2002; Van Herzele and Weidemann, 2003). Hillsdon et al. (2006) reported no association between recreational or physical interaction and GS accessibility in their UK study. This is supported by Witten et al.'s (2008) New Zealand research that concluded there was no relationship between access to open spaces and physical activity.

These results do not underlie the importance of the HWB benefits of having nearby and accessible GS. This aspect, along with many other eco-spatial characteristics and attributes noted within this research, expresses the concept of 'Nearby Nature' or local green spaces and GS accessibility, as discussed in many studies. Nielsen and Hanson (2006), in their Denmark-based study, reported that individuals who had access to gardens and lived within a short distance to GS reported less stress. Similarly, Pretty et al. (2005) found GS physical interaction increased self-esteem and reduced emotions such as anger, depression and tenseness in UK residents. Additionally, Kuo and Sullivan (2001) reported lower levels of aggression and violence among individuals with nearby nature (i.e. GS with trees) due to lower stress levels and mental fatigue.

GS accessibility and its relationship to HWB affordances is constructed of multiple dimensions. This study measured physical proximity or measurable distance to nearest GS and whether or not it was visited. This does not tell the whole story, however. This study relies on measures of access based solely on physical proximity, as measured in distance and does not consider other factors that might influence access, such as participant mobility, neighbourhood walkability and/or safety, individual motivation (Gobster, 2005), or other socio-cultural factors that might make local GS feel inaccessible despite physical proximity (Strife and Downey, 2009; McCormack et al., 2006) or the other characteristics and qualities (Pauleit et al., 2003) such as those reported.

Additionally, research has shown that GS are used differently in each country depending on their availability and accessibility. Another reason for variability in interaction may be specific cultural views, concepts and values of

nature. For instance, the Spanish do not associate nature with urban settings; they do not recognise urban parks or urban trees as being part of 'nature' (Priego, Breuste and Rojas, 2008).

10.6.4 Safe Assemblages

The relationship between a GS's sense of safety and security, and human interaction, is complex and situated within environmental psychology's concepts of perception and preference as discussed earlier. Ozguner and Kendle (2006) reported that individuals felt more safe within more managed garden types of GS (e.g. gardenesque styled GS vs. those more naturalistic/wild).

Jorgensen et al. (2002), in their UK study, reported safety preferences for GS that were less enclosed, or open with minimal or low horizontal vegetation. Kuo et al. (1998) in their US study, however, found that more trees created a safer environment for respondents. This contrasting literature is supported within this research's findings. In the Paisley CA, respondents interacted with GS reported as safe and having characteristics of *Transparent Edge Density* (n=38, 64%) and an open vegetation density (n=46, 61%), whereas in the Vantaa CA, an open vegetation density was not predominately considered a Safe characteristic for all GS (n=23, 39%), it was only considered *Somewhat Safe* (n=35, 59%), and a *Transparent Edge Density* (n=33, 69%) provided for *Somewhat Safe* characteristics.

Jorgensen et al.'s (2002) study in the UK reported that woodland was many people's favourite place, although often seen as unsafe. This is not supported by this research where, in the Paisley CA, woodlands were the fourth most visited GS typology, and these woodlands contained both *Safe* (n=5) and *Somewhat Safe* (n=5) levels with minimal *Unsafe* (n=1) characteristics. In the Vantaa CA, however, woodlands were the most visited typology, and these were considered predominately *Somewhat Safe* (n=33) and *Unsafe* (n=7), with *Safe* (n=5) not being a typical attribute level. Ozguner and Kendle (2006) reported, in their UK study, that both naturalistic and formalised GS provided levels of safety and security.

Additionally, physical proximity to a park does not mean that residents feel safe or comfortable in using it, given the potential for real or perceived concerns over safety or discrimination (Gobster, 2002, Lindsey et al., 2001). *Proximity* may

not be an appropriate measure for human wellbeing since this can vary based on demographic and socio-economic characteristics. Day and Wager (2010) found that less affluent children in Scotland are more limited in their use of parks than more affluent children, suggesting that proximity may be more important in low-income communities than in wealthier areas.

Many studies on the use of GS show that women have different experiences, particularly in respect to personal safety, than do men, particularly when they are alone (Burgess, 1998). This study found no statistical significance in either of the CAs between females, their HWB interaction, and the *Density, Visibility, Enclosure, Facility and Safety and Security* eco-spatial attributes of the PPUIGS they interacted with: both males and females interacted with very similar PPUIGS characteristics. These results do not support that of others, however. For example, Jacqueline Burgess' Woods Project (Burgess, 1998) revealed that the physical quality of enclosure characteristic of woods and forests (e.g. density of tree growth, height of trees, thickness of the tree canopy) was experienced negatively by women. This research did not measure an individual's subjective level of safety, however, only those eco-spatial characteristics considered indicative of safety such as presence of lighting, signage, views within and out of the GS, and edge transparency (e.g. Safe Eyes) (See Figure 10.43). As such, drawing conclusions as to an individual's feeling of safety is strongly discouraged.





Figure 10.43
Safe GS Characteristics – Lighting, Signage, Visibility, Edge Transparency (Vantaa, Finland – top and Paisley, Scotland - bottom)

Literature reports that often women cited the naturalistic or nature-like characteristics of parks as the reason for preferring this GS characteristic as parks contained the spiritual qualities and the sense of freedom preferred by women (Krenichyn, 2006). This knowledge and other insights, such as those in Pretty et al. (2005), imply that there are certain benefits which outdoor landscapes and GS provide that cannot be attained through indoor recreation or physical activity.

Woodland safety levels, however, often conflict with management goals for natural landscape settings (Nilsson et al., 2013). Both CAs reported increased HWB affordances with *Natural and Semi-Natural* PPUIGS. This has been echoed by Burgess et al.'s UK study (1988), which notes that more naturalistic settings, especially woodlands, are among the most highly valued landscapes in terms of personal pleasures, sense of wellbeing and the contact with nature they afford people, but they are also the setting in which many people feel anxiety either for themselves or their loved ones (Burgess et al., 1988). Similarly, in a Finnish study, unmanaged areas were valued highly by some participants and regarded with dislike and fear by others (Tyrvainen et al., 2007). Both measures can be achieved, however: for instance, by reducing shrubs and raising tree canopies to improve visibility at ground level, while preserving a sense of naturalness.

10.7 Research Question 5

How can landscape planning and design in the context of dynamic polycentric urbanising landscapes contribute to improving human wellbeing?

The key findings of this research have design, management and policy implications for the many planners, landsape architects and designers within each region studied. In the UK, UGS and open spaces have become an increasing policy priority over the past decade (e.g. PPG 17, Urban Green Spaces Taskforce, OPDM, CABE Space) and most of this policy work includes the awareness of their comprehensive benefits to both humans and nature. Often referred to as a 'Green Space Strategy' within smaller, local, municipalities, these strategies often lack comprehensive spatial planning and land use strategies, however. For example, although UK planning policies, such as Planning Policy Statement 3 (Department for Communities and Local Government, 2006), require GS to be incorporated into urban planning, there are currently no minimum requirements to ensure these guidelines are met. Only recommendations have been provided: English Nature suggests that people in urban areas should be able to access a green space of at least 2 hectares in size within 300m or a 5 minute walk of their home (English Nature, 1995).

Meanwhile, the ESDP's policies relating to multifunctional, polycentric regional planning and development, considerations of ecological services and the landscape resources remain deficient, focussing on functional polycentrism through predominately prescriptive land use and economic indicators (Blueprint for Euroscape 2020—Reframing the future of the European landscape, 2008).

Helsinki, and its surrounding Metropolitan Region, began adopting an urban consolidation planning approach to replace its long-standing densification oriented policy in the late 1990's (Jaakola, 2013). The National Land-Use Guidelines for Finland have an objective of 'a more consolidated urban structure and the quality of the living environment' (Ministry of the Environment, 2002). The term 'quality' is noted as being economic, ecological and social/cultural focused. Furthermore, this urban consolidation policy is enacted through accessibility – accessibility to services, the environment, and people. This is a much more inclusive concept than

the ESDP and reflects the concept of landscape services within a distinctly socio-ecological landscape. Although the HUR has focused on accommodating human development in its polycentric form primarily through housing density, results are inconclusive, however.

Finland manages its urban growth in the HUR by promoting low-density development to maintain the rural character, as opposed to the City of Helsinki's inner densification. The Helsinki Green Areas Strategy within the Helsinki Master Plan will bring together three distinct green space concepts: recreation and wellbeing, city identity, and ecological sustainability. These planning projects include continuing urban densifications within the city's core and harbour redevelopment while maintaining existing green structures. The Open Space Strategy for Helsinki is currently (2016) in operation through the Environmental Office of the Helsinki City Planning Department.

Paisley and the Greater Glasgow Urban Region, Scotland

The agglomerated context of GS within this region (e.g. large Country Parks) is a significant asset to the residents; interconnectivity between these county parks and the larger rural hinterland should be maintained, particularly as pressures for development continue. It is not clear whether densification initiatives would be successful, however. To accommodate future urbanisation through population increase, the region should continue regenerative and brownfield reclamation landscape projects and actively assess the socio-ecological benefits a GS provides prior to its development. Specifically noting that residents find the most frequent and most diverse HWB benefits from parks and woodlands.

Results indicate that social-based HWB affordances were the least frequent benefits received through PPUIGS interaction; this may indicate that more eco-spatial characteristics that encourage the reception of social-based HWB benefits could be incorporated. The regional councils should note this and actively modify policy and management plans. For instance, as human development expands outwards into the larger region, this research shows that increased GS fragmentation would bring increased HWB benefits, but only if the green structure

interconnectivity is maintained, and perhaps strategically increased. The threshold of landscape fragmentation for the region can be examined in future research. Future IntGS within the polycentric urbanisation of the GGUR will provide benefits to humans.

Vantaa and the Helsinki Urban Region, Finland

The 'Green Fingers' is a simple concept used for defining the core structure of green space in HUR. The agglomerated context of green structure within this region (e.g. 'Green Fingers') is a significant asset to the residents. Surprisingly, it does not contain any specific policy instruments to maintain and strengthen the status of this basic structure as it essentially is a group of various municipally managed GS within a larger, conceptual spatial form. Though 'Green Fingers' is a strong mental structure within the cultural mindset of many residents, no practical legislation currently exists to maintain the integrity of these green structures.

The 'Green Fingers' are greenways serving as integrated functional socio-ecological networks linking urban and rural, such as Helsinki Central Park originally was, and to some extent, still is (Ahern, 2003), as are the other fingers. As urbanisation has increased, the need for transportation infrastructure has led to ring-roads which bisect the fingers. Interconnectivity between the urban core and the larger rural hinterland should be maintained, particularly as pressures for development continue due to population increase. Expanding interconnectivity concepts of the 'Green Fingers' into the larger region could create a 'Green Mitten' (See Figure 10.44).

Although densification will be the preferred development policy as future urbanisation arises (Jaakkola, 2012), there are no specific plans for where and how this urbanisation will occur. These compaction policies will further increase the pressure on remaining GS. The region should consider actively incorporating legislation to protect and manage the integrity of the existing 'Green Fingers'. Although geomorphological constraints will limit development opportunities, this does not mean that HWB will be maintained. The region's government and councils will manage urban growth through their Municipal Plan (*yleiskaava*); however, green structure plans do not appear in Finnish legislation, nor, usually, in

the practice of Finnish municipalities. Adding to the policy-driven concerns of the 'Green Fingers' is the socio-political context surrounding GS. Spatial planning has not required GS to be a key concept in Finland; most planning refers to these GS through their actual uses such as agriculture and forestry. The HUR must actively consider which eco-spatial characteristics of its GS provide the most important wellbeing benefits to its residents; forests cannot be the predominant land cover in perpetuity.

It is important to note that there is currently (2016) no policy to maintain the existing structure (e.g. Green Fingers) of GS interconnectivity and coherence within the Vantaa PUR and the HUR. As a result of the drivers and pressures discussed, particularly urban consolidation and densification, development adjacent to the green fingers, i.e. wedge development, is expected to continue.

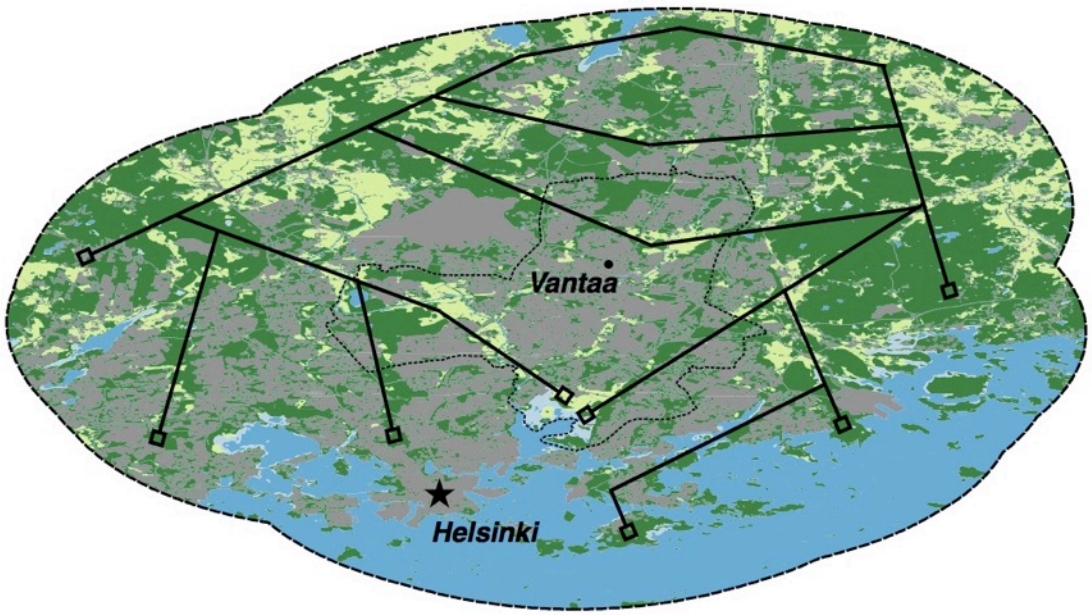


Figure 10.44
Helsinki Urban Region Green-Mitten Structure
Green Structure connections to Regional Greenbelt Structure

Comparative Summary

The current state of the HUR's and GGUR's PUL and PPUIGS are in transition. And the various GS present exhibit various states of this transition, but they all do share some physical characteristics: physically fragmented within a

larger spatially heterogeneous socio-ecological, hybridised landscape of a polycentric region. Although Paisley's PUR exists in a state of early- to mid-level spatial fragmentation, Vantaa's PUR is on the tail end of landscape fragmentation. As such, the morphological structure and spatial characteristics found within Vantaa's PPUIGS may offer insights into how to proceed with the future policy planning and management of the Paisley PUR. For instance, as urbanisation and landscape fragmentation continues in the GGUR, which will further heterogenise the landscape, creating many smaller, proximal, interstitial GS, these GS should be proactively designed and managed to continue providing HWB benefits. Not only should the GGUR reflect the green infrastructural connective morphology of the HUR, but, as this research has shown, these GS should ideally have the following characteristics within its design and management goals to provide the most HWB affordances to a wide population (See Figures 10.45 to 10.52):

- Simple Shape (3-4 sides and uniform such as square/rectangle);
- Few Number of Edges (3-4);
- Uniform Horizontal Vegetation (mostly grass and low shrubs);
- Clustered Vertical Vegetation (clumped tree distribution);
- Semi-Natural Vegetation Composition (feels semi-wild, diverse vegetation);
- Extensive Views within GS (3+ long views in/out of GS);
- High Sociability due to Facilities (formal/informal open spaces w/benches, tables, seating, etc);
- Somewhat Safe (some lights and open edges, fair visibility).





Figure 10.45
GS Characteristic - Simple Shape
(Paisley, Scotland – Bashaw Park)

In the above images, most GS have only 3-4 sides and are of uniform shape such as a rectangle, triangle, circle, or square.



Figure 10.46
GS Characteristic – Few Edges
(Paisley, Scotland – Paisley Abbey GS)

In the above image, the GS has only 3-4 edges.





Figure 10.47
GS Characteristic – Uniform Horizontal Vegetation
(Vantaa, Finland)

In the above images, the GS have primarily grass and low shrubs within its horizontal vegetation structure.



Figure 10.48
GS Characteristic – Clustered Vertical Vegetation
(Paisley, Scotland)

In the above images, the GS have primarily clumped and unevenly distributed tree vegetation with massed groupings of trees within its vertical vegetation structure.



Figure 10.49
GS Characteristic – Semi-Natural Vegetation Composition
(Vantaa, Finland – top and Paisley, Scotland - bottom)

In the above images, Regardless of facilities or amenities including paths, lights, bins, benches, centres, toilets, the GS still has a natural feeling to it and a few informal recreation opportunities (beyond trail walking, wildlife viewing, etc) with a variety of vegetation types or limited types of habitats and with some natural or naturalistic vegetation or areas. Agricultural Fields and Grazing Lands are often considered of this Setting.



Figure 10.50
GS Characteristic – Extensive Views
(Vantaa, Finland – top and Paisley, Scotland, Brodie Park - bottom)

In the above images, within the GS, many (3+) long and expansive views, both within the GS and/or out from the GS.







Figure 10.51
GS Characteristic – High Sociability
(Vantaa, Finland – top and Paisley, Scotland, Fountain Gardens – bottom 2)

In the above images, the GS has exposed spaces with many places for social interaction, both formal & informal. There may be a designated dog space and many benches and seating areas, as well as the possibility of a playground or communal area. These GS can accommodate large groups.



Figure 10.52
GS Characteristic – Somewhat Safe
(Vantaa, Finland – top and Paisley, Scotland, - bottom)

In the above images, within the GS, there is often the presence of lighting, locked gates, open edges, and/or visibility in/out, but only with some lights and/or some edges are open. Visibility is acceptable at most places.

Polycentric Peri-Urban Landscapes and the DPSIR Model Response

This research conceptualised and modelled each PUL's human-nature relationship through the DPSIR framework and generalised the results within Figure 10.53. The outcomes support many current relationships: human activities generate pressures on the landscape, and these pressures in turn change the state of the larger system, which leads to impacts on HWB. But not all of these impacts are negative upon HWB. Ultimately, DPSIR is an action-oriented and policy framework. These actions, however, involve trade-offs and decisions in their application that have an impact landscape services, both directly and indirectly.

This research has provided an Integrated Affordance Model (See Chapter 5) to depict how the socio-ecological landscape functions to produce landscape services that benefit HWB. By including HWB benefits and landscape services in addition to the typical 'impacts' found within the DPSIR model, a wider diversity of information is available to decision makers. The landscape services and HWB benefits identified in this research exemplify an asset-based approach to landscape planning.

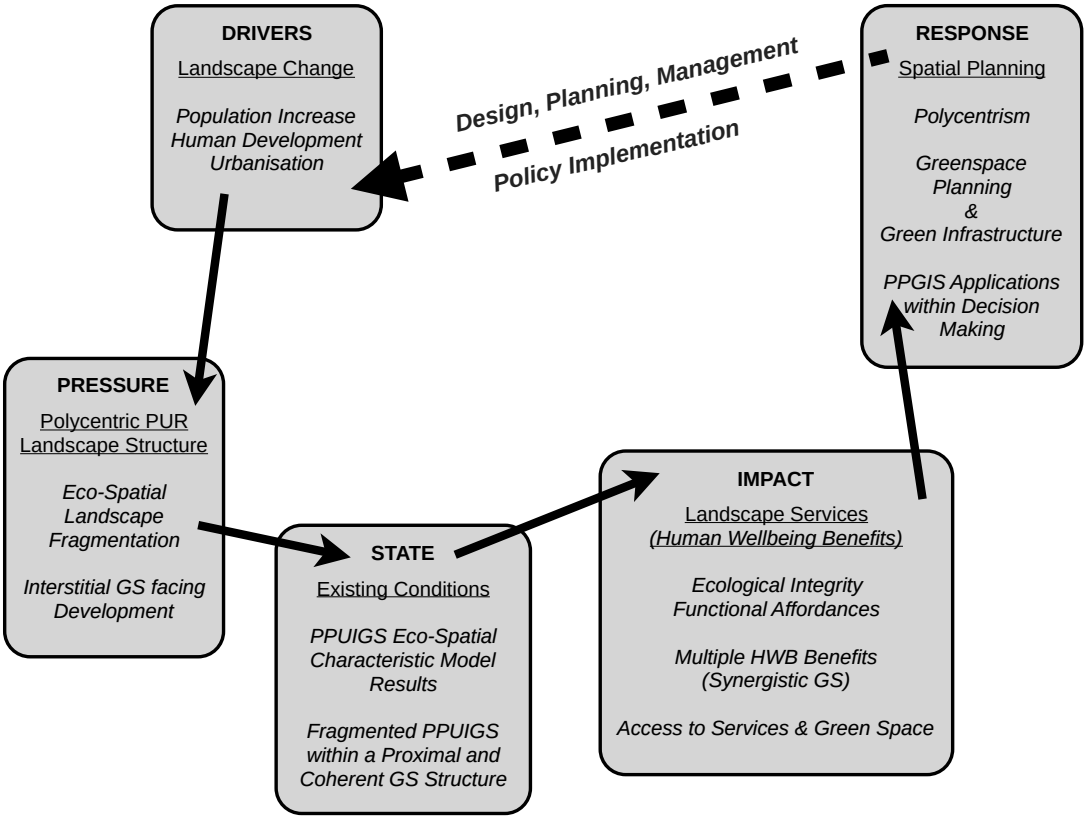


Figure 10.53
Generalised Case Study DPSIR Model

A salient example is the following: it is the PPUIGS that are most affected by urbanisation pressures. Within urbanising landscapes, structural elements are constantly being removed, added or modified. In most cases, the land cover, which was once of a dense vegetative quality or woodland, changes to decreasing levels of vegetative intensity and ecological integrity and impermeability. Then, it may, all of sudden, be converted for human development such as housing or commercial development. Or, alternatively the PPUIGS, often a leftover parcel, are left as an unmanaged and uncultivated GS such as a greenfield or brownfield, and its vegetative land cover may become more dense over time through natural regeneration and ecological succession or human actions to apply reforestation strategies, thereby, once again, providing ecological services and HWB benefits.

Polycentric development patterns in urbanising regions of the UK and Europe have proven beneficial for humans, particularly in their functional and economic

basis. Yet this has consequences, GS fragmentation being one. As with any spatial planning approach, the advantages and disadvantages must be considered across multiple fields/aspects. As academic literature evolves and data is gathered on the success and effects of polycentric development, it will be important to monitor both PUR's and Europe's polycentric development policy. Specifically, what other functional linkages may be explored within a PUR such as HWB and QOL. This research adds to such discussion.

It is not clear if there can be an improvement upon the polycentric morphological form to provide HWB benefits. The process of an urban region transferring from being monocentric to polycentric, or simply evolving into a polycentric region is dependent upon many factors. Yet many of these process are simply an extension of the urbanisation process - whether in a polycentric form or not.

The issues of concern discussed within this thesis for each PolyPUR – landscape and green space fragmentation which occurs through the spatial development process – can be best managed at the peri-urban scale through multilevel governance. This reseach provides another ecosystem service (or unit – e.g economic, social, technological, environmental) to be considered within the spatial planning process – HWB, thereby providing a level of integrated development planning.

The polycentric rural-urban linkages within each PUR of this research are primarily identified through ecosystem services and economic flows as discussed in Chapter 3. HWB is considered within existing policy to be more of an indirect ecosystem service – similar to amenity, leisure, and aesthetics. However, this research provides scientific evidence of explicit relationships between green structure found within PolyPURS and HWB benefits or affordances, thereby facilitating another linkage or unit of reference to be incorporated into the spatial process of each PUR.

This research's findings provide spatial and scalar characteristics of factors of GS which sustain and enhance landscape services or multi-functional benefits to multiple units – economic, social, environmental and, now, human wellbeing. As

discussed prior, the Vantaa CA residents seem to be lacking in, overall and generally, opportunities for Psychologial affordances from their GS. This research shows that GS can be designed, planned and managed to deliver Psychological affordances if the GS is more Diverse and Random in their vegetation structure placement with many different vertical vegetation types whose diversity is visually dominant and the distribution is many and informal/wild as well as more Dense with clustered plantings, crowded and tightly-packed. This strategic or pro-active GS planning and design approach not only maintains ecological integrity, but also adds to the synergistic or multi-functional HWB benefits to humans, maintaining those existing social and physical affordances.

Peri-urban spatial configurations must strive to be more conducive to promoting the wellbeing of their human populations and biophysical landscapes as these are the most rapidly changing environments in Europe. Managing the growth of polycentric regions is critical to maintaining the inherent benefits of this morphological concept. Perhaps then, it is a tempered polycentric development pattern – one that is a mixed-approach (hybrid), and which considers existing land uses as much as functional needs/benefits. Maybe, it is a polycentric strategy that provides a set of conditions or characteristics rather than defined locations, thereby creating a non-hierarchical pattern of randomly distributed GS – an interstitial pattern within the developing urban fabric. It is important to recognise that polycentrism in this research's paradigm is a process, not a structurally determined morphology, which is able to maintain the emerging structure around socio-ecological landscapes and their GS.

Perhaps polycentrism within the EU begins to take on a pattern of interconnected Peri- Urban GS within each conurbation's fringe-areas or Polycentric Peri-Urban Regions. Landscape and GS fragmentation has not fully impacted these zones, and proactive spatial planning, design and management will have significant influence on how these regions develop morphologically. Yet it is critical that urban development does not fill in these PolyPURs, thereby increasing monocentric patterns of development. Lastly, utilising PPGIS strategies such as SoftGIS, whether operationalising Affordance Theory or not, will improve

knowledge of how exactly citizens and communities use (or value) these GS, thereby informing better management and policy actions with direct support for decision making to achieve higher functional and performance landscapes.

It can be considered that the urbanisation process ‘fills-in’ the gaps of landscape fragmentation caused by earlier peri-urbanisation, thus completing the landscape - filling in the interstitial voids and moving from a heterogeneous landscape to one which is more homogeneous spatially, although not necessarily functionally. This de-fragmentation process occurs as the human development patterns continue, potentially minimising and eliminating IntGS. However, landscape heterogeneity increases aspects of functionality within biodiversity as it allows landscapes to maintain structure and ensure resilience (Forman, 1995; McGarigal et al., 1995; Kim & Pauleit, 2009).

A major goal of urban ecology is to understand the relationship between the spatial pattern of urbanisation and ecological processes (Pauleit and Duhme, 2000; Wu and David, 2002). The spatial pattern of land use reflects underlying human processes and influences the structure and biophysical fuction of PPUIGS. Human development and urbanisation modify PULs increasing landscape fragmentation and creating more and smaller GS. This research has shown that ‘fringe’ or PUL areas are integral elements of urban systems (i.e., as extensions of cities and urban centres), and is concerned with how those IntGS, and to some degree PUGS, often viewed as leftovers or remnants of more natural spaces (e.g. agricultural, farmland, woodland), are considered as areas for future development and not viewed as GS with significant value (Alm, 2007).

Landscape planning, in theory, strives to determine land use activities so that human needs and desires are met while minimising the negative ecological impacts of these human interventions, often acknowledged through the concepts of structure, function and change within landscape ecology (Forman and Godron, 1986). This research illustrates how socio-cultural and ecological dimensions of their dynamics can be considered in creating a sound analytical framework that informs planning and governance. To support this, a growing empirical base confirms that urbanisation and landscape fragmentation profoundly affects how

humans connect with, and receive benefits, from green spaces and green structures. Although ecosystem functioning and biodiversity impacts, and their relationships to socio-ecological systems, are not yet fully understood (e.g. Haase 2014), the drivers of land use change and the conditions within which these systems operate, are more clearly known. With this research's knowledge, research and practice can better assess the human-nature relationship within place-based conditions specific to those landscape patterns, forms and processes, as well as the continued integration of natural and social sciences.

The concept of *Greenstructure Planning*, similar to green infrastructure, has been adopted in some northern European countries (notably Norway and the Netherlands) as a means of linking consideration of the human-nature relationship within spatial planning and design. The spatial planning frameworks of Greenstructure Planning emphasise the inherent adaptability of landscape services in respect to their ability to provide multiple types of benefits in a variety of situations. This multi-functional, and even flexible, aspect of ecosystems and green spaces (Rodriguez et al., 2006) is of significance and can be utilised effectively within the changing context of human-based needs and expectations.

The notion of landscape as infrastructure, or as a service matrix, that has been put forward by landscape urbanism (Waldheim, 2006) which expands green infrastructural concepts is most appropriate to envisioning the multifunctional role of PURs and their PPUIGS. Landscape urbanism combines design and ecology, whereby the landscape is seen as a "*hybridization of natural and cultural systems*" (ibid). As an applied theory to landscape architecture, spatial planning, and urban design, the landscape is seen as the 'background' of urban agglomerations, i.e. the matrix wherein the city is embedded. The rural hinterland is regarded as the infrastructure for human development, and the peri-urban region allows for their indeterminate interrelationships to evolve together. The benefits of such a multi-functional landscape are many, including increasing the region's integrity, adaptive capacity and resilience (Botequilha-Leitão et al., 2006). Landscape urbanism's spatial conception is thus a more integrated acknowledgement of green

infrastructure within the socio-ecological landscape as viewed through landscape services.

Although this author prefers to not use the term sustainability in discussions, its consistent use and policy objectives require further analysis. Sustainability is a term that straddles the social and natural sciences. Be that as it may, sustainable development is a socially-defined concern. Lack of sustainability results from human actions upon the environment, thus sustainability becomes a social-based issue, not an ecological-based one. Elaborating on the ideologies of Bruno Latour, Becker and Jahn (1999) note that the issues of concern (e.g. fragmentation, place identity, human benefits) within a socio-ecological system are the *"intersection of social practices and natural processes as socially constructed forms of mediation between society and nature"*.

Though sustainability can have many different meanings (Massachio, 2009), most green infrastructure and ecological definitions highlight the desire to maintain resilience and integrity in environmental and social systems by meeting a diverse range of interconnected environmental, social and economic, and institutional goals (Swart et al., 2004). This research has demonstrated the reciprocal relationship between environmental (natural) and social (cultural) systems and the continued procurement of ecosystem services, but economic considerations must be included in this model to promote dialogue regarding sustainability – thus the term landscape services becomes salient.

The concept of resilience (as opposed to the concept of sustainability, for example, which implies maintenance of a stable state) is useful for spatial planners. Resilience is a measure of the system's capacity to absorb change, and some systems are more resilient than others (Spirn, 1984). Socio-ecological resilience can be understood as the ability of a system to learn from dynamic events and to adapt reactively and proactively to changing environmental conditions.

Spatial planning practices must continue to evolve. The integration of sociological and ecological systems may not provide the outcome desired, however. Ecologists have warned that merging the two systems may result in undesired outcomes such as habitat and species loss (Agrawal and Gibson, 1999).

Sociologists cite the lack of demand for a more integrated form of green space planning and design (Bowman and Thompson, 2012), such as new urbanism. Furthermore, classifying ecosystem services has its complications.

Notwithstanding the above, both humans and nature benefit when these resources are perceived and planned as an interconnected system, whether directly or indirectly (Lovell and Johnston, 2009). Green infrastructure planning provides a framework to understand these concepts within the larger context of the fields of natural sciences and social sciences. Madureira et al. (2014), likewise, emphasised the importance of establishing green infrastructure as an integrated and coherent system of multi-functional green spaces that link the city with the countryside through biophysical and social infrastructure. One of the key conditions that this definition is built upon is spatial connectivity (ibid).

It is through this evolving integrated socio-ecological framework in spatial planning that the numerous and diverse benefits and services to humans and nature can be further studied and acknowledged (e.g., de Groot et al., 2002; Benedict and McMahon, 2002).

10.8 Results Discussion Summary

This research has provided empirical evidence of the relationship between PPUIGS fragmentation and the provision of HWB benefits. It was developed in recognition of important gaps in green space research specific to peri-urban areas and their relationship to ecosystem service benefits: specifically the need to account for human-based benefits such as wellbeing in the human development process across Europe. This study has therefore reported upon key issues salient to urban development within the UK and Europe and provided evidence on which to base future decisions within spatial planning and design, as well as identifying topics requiring further research and analysis. This research was presented in a way that is accessible to academics, practitioners and decision-makers and can be applied through journal articles, publications, and presentations. This research can encourage multidisciplinary inquiry and comparative investigation in order to further develop and integrate recommendations into a comprehensive spatial planning framework.

Table 10.1 summarises the main research main findings, which describe this complex relationship. Each finding is discussed in detail after the Table.

- Interstitial green spaces (IntGS) within polycentric peri-urban regions are transitional green spaces and are more physically fragmented, contain more edges - particularly transitional edges - and exist within a more diverse land cover and land use context, and spatially heterogeneous landscape setting, than other morphological configurations.
- The fragmentation of green spaces and green structures found within polycentric peri-urban areas of Paisley, Scotland and Vantaa, Finland and does not negatively affect the production of psychological, social and physical wellbeing benefits to humans provided through interaction.
- Even though the Vantaa PUR and larger HUR is more morphologically polycentric and contains more spatially fragmented GS than the Paisley PUR and GGUR, its PPUIGS exhibit distinct aspects of overall spatial connectivity and a proximal structure of physical coherence among them, thus providing a more comprehensive set of physical, social and psychological HWB benefits to its residents.
- This research reported that neither the moderator variables (demographics, socio-economics) nor the mediator variables (human wellbeing benefits achieved from GS interaction) exhibited strong influence over the relationship between the eco-spatial characteristics of the PPUIGS interacted with and life satisfaction.
- There were no statistically significant PPUIGS characteristics and attributes shared between the PPUIGS of the case study regions and HWB affordances. However, statistically significant trend results indicate respondents for both CAs received psychological HWB affordances from naturalistic and physically connected PPUIGS, social HWB affordances from PPUGS with edge effects, and physical HWB affordances from linear shaped GS.
- Overall, to achieve all HWB affordances respondents most frequently interacted with PPUIGS that was: natural-shaped; uniformly vegetated horizontally – often with grass; extensively sized and physically connected

to another GS; considered part of a larger group; with moderate-sized edges; and close to or adjacent to a heavily-trafficked road; moderately clean and somewhat safe.

- Within the Paisley PUR, multi-beneficial HWB PPUIGS are, generally, simple and regular in shape with 3-4 sides and are considered one in a group of many nearby or connected GS that contain mostly grass or low shrubs and clustered and clumped trees so as to feel semi-natural or somewhat wild, with many long views within them. These GS are most often close to a major motorway or heavily trafficked road, with exposed spaces that offer many places for social interaction, both formal and informal, as well as many benches and seating areas, some lights and some open edges with adequate internal visibility, and perhaps a playground or communal area that can accommodate large groups. Park assemblages in the Paisley PUR are very important multi-beneficial PPUIGS where respondents were able to receive the full suite of HWB benefits. Results show these multi-functional parks were most often associated with interactions with Pollock Park and Barshaw Park.
- Within the Vantaa PUR, multi-beneficial HWB PPUIGS are, generally, large and extensive in size that separates views to other built structures when within them; typically contain mostly grass or low shrubs; and are most often close to a major motorway or heavily trafficked road. Woodland assemblages in the Vantaa PUR are very important multi-beneficial PPUIGS where respondents were able to receive the full suite of HWB benefits. Results show that these multi-functional woodlands were most often associated with interactions with Paloheina Woodlands and the Fastholma Green Space.
- Paisley CA residents, regardless of gender and aged 45-54 with a household annual income level of 20,000 – 30,000 BP on average, mostly visit both far away green spaces (over 2 km distance) and nearby green spaces (within 400 m), both by car, without their dog, at a Park green space typology, most often Pollock Park, to achieve psychological HWB benefits.
- Vantaa CA residents, regardless of gender and aged 25-44 with a household annual income level of 30,000 – 35,000 Euro on average, mostly visit far

away green spaces (over 2 km distance), by walking or by bike, without their dog, at a public woodland green space typology, most often Lamasaari Island, to achieve physical HWB benefits.

- The density of edges (transparent vs. opaque) and vegetation structure (dense and clustered vs. open and random) was shown to be influential in HWB affordances in both PUR's PPUIGS.
- Respondents within each CA, generally, based on the highest frequency of their interactions, utilise their GS for different HWB benefits – specifically, most respondents visited GS for psychological benefits (41%) in the Paisley CA and most resondents visited GS for physical benefits (54%) in the Vantaa CA. The common eco-spatial characteristics for these particular GS included:

    Within case study area boundary

    Titled or Named

    Public ownership

    No special designation

    Park Typology

And the people that visited these GS for those affordances included:

<u>Paisley CA Respondents</u>

Age: 45-54

Gender: Male

Dog Ownership: No

Car Ownership: Yes

Household Income: 20,000 – 30,000 GBP

Education level: SVQ Level 3

Life Satisfaction: Highly Satisfied or Satisfied

Deprivation Ranking (Paisley): Income 20-100% median

- <u>Vantaa CA Respondents:</u>

Age: 35-44

Gender:Male

Dog Ownership: No

Car Ownership: No

Household Income: 30,000 –40,000 EURO

Education level: Vocational Diploma

Life Satisfaction: Highly Satisfied or Satisfied

Poverty Risk Ranking (Vantaa): Income >60% median

- Generally, people within each CA visited certain types of GS in order to achieve physical, social and psychological HWB benefits – here, predominately parks (55%) for the Paisley CA and woodland (37%) for Vantaa CA.
- Respondents within the Paisley, CA reported a slightly lower self-reported level of life satisfaction than those for the Vantaa, CA.
- Proximity to a GS does not indicate use. Only 32% of Paisley respondents visited their nearest GS, as opposed to 44% of Vantaa respondents. Respondents in both CAs distinctly visited GS beyond a 2 km distance or a long vehicular ride (28% Paisley CA, 44% Vantaa CA).

Table 10.1
Main Research Findings Summary

Chapter 11 - Conclusion

11.1 Introduction

This Chapter addresses the contributions of this research, its strengths and limitations, its implications for policy, spatial planning, and landscape architecture, and its ideas and direction for future research, and ends with the research's key conclusions.

11.2 Research Contributions

The findings of this research show that polycentric peri-urban residents receive many benefits from these GS beyond traditional ecosystem services, including benefits specific to psychological, socio-cultural and physical wellbeing. Although this study analysed two socio-culturally different regions, results suggest that, while differences may exist between an individual's factors, similar wellbeing benefits are received across similar fragmented green space characteristics, illustrating the importance of PPUIGS for wellbeing and LS.

Although the relationship between HWB and PPUIGS is complex, this study concludes that the green spaces and green structures that exist within the polycentric, fragmented peri-urban regions of the UK and Europe do not detract from HWB, but rather provide unique benefits not found in other landscape configurations.

This research and literature review has served to clarify definitions of important concepts such as landscape, urbanisation, greenspace, and landscape services, especially as related to HWB. It does not present an alternative paradigm to study PULs; rather, it builds from an ecosystem perspective (Golley, 1993) to provide an alternative means to study the integrated, hybridised landscape within the study's unique context – PPUIGS. The research finds support for its interrelated approach in systems theory, the cognitive sciences, DPSIR models, and transactional paradigms specific to the human-nature relationship. It offers new experimental contexts in which to conduct future investigations on the relationship between landscape forms, patterns and processes, and their specific relationship to

humans and wellbeing benefits, thereby providing a conduit and approach that traditional frameworks cannot provide.

This research considered specific actions in specific spaces. It was able to account for the reciprocal relationship between individuals and the landscape. whereby the individual's action or behavioural interaction occurs in some specific setting, in order to find the meaningful relationships between humans and nature. Heft and Kyttä (2006) would agree on this approach. Whereas environmental psychology has focused on environmental meaning and cognitive perception, with little attention being given to the physical characteristics of places, transactional-based research situates meaning relative to the actions of the individual within a spatio-temporal context.

The socio-ecological approach found within landscapes of affordances andn the PPUIGS Index encourages researchers and designers to think about complex landscape-individual processes in relational terms. In doing so, research will add not only to environment-behaviour studies but the spatial planning and design professions as well – creating physically, psychologically and socially meaningful descriptions of the environments in which we live and interact.

Landscape fragmentation impacts the biophysical landscape and ecological functioning of the landscape – its ecosystem services. Additionally, landscape fragmentation impacts the socio-cultural landscape and anthropological functioning – its societal, cultural, and economic services. Together, landscape fragmentation impacts the comprehensive notion of landscape services. But, it is important to note that not all these impacts are negative. For example, landscape fragmentation may increase overall biodiversity and some niche species may prosper within these landscapes. Similarly, landscape fragmentation as exemplified through the peri-urbanistion process adds infrastructure and enables access to services such as hospitals and shopping as well as reducing poverty and increasing safety. Landscape fragmentation may also increase access to leisure access within green spaces.

As PolyPULs change – and as they impact and are impacted upon within the complex human-nature systems of interaction – people will seek out the best

landscapes in which to achieve their highest function, here, HWB and LS. Thus, individuals seek out those landscape-based eco-spatial configurations and characteristics that allow them to achieve the best performance of HWB benefits. Alternatively, people are capable of modifying the landscape to achieve certain benefits and services.

Within Affordance Theory, the individual is an active and integral participant of landscape change. In this regard, the PUL exists within a constantly changing, cyclical state, in which the landscape is changing and in which people independently affect that changing landscape, thus requiring a response or mediation in order to maintain, improve or even negate affordances. Building from prior models, this integrated concept is reflected in Figure 11.1 – Conceptual Landscapes of Affordance Model within Socio-Ecological Polycentric, Peri-Urban Green Spaces and Green Structures.

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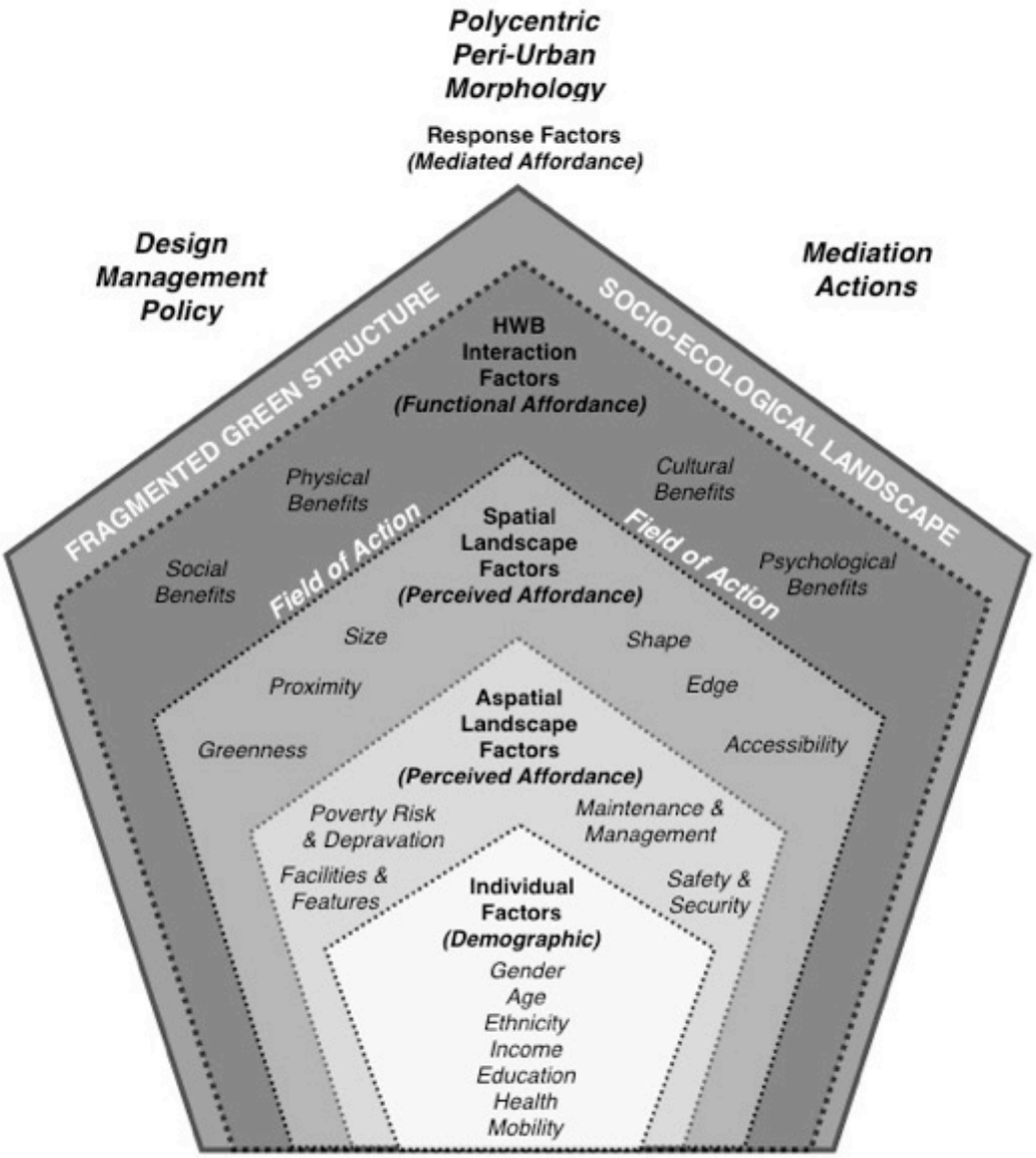


Figure 11.1

Conceptual Landscapes of Affordance Model within Socio-Ecological Polycentric, Peri-Urban Green Spaces and Green Structures

This conceptual framework, as well as the DPSIR model, integrates spatial form, green space and social dimensions of human and ecological functionality within distinct polycentric, peri-urban landscapes.

This research's Landscape of Affordances perspective allows landscape architects, planners, policy makers and others another set of empiric criteria in which to strategically design, plan and manage green spaces and green structures in

order to achieve multi-functional spaces. Not only do these results show which specific GS characteristics are conducive to which specific HWB benefit or affordance, but the PPUIGS Index from which these characteristics were measured and analysed have associated ecological integrity or ecosystem patch dynamic characteristics as well. This research provided a successfully applied and tested indicator model, the PPUIGS Index, to measure and analyse socio-ecological aspects of ecological integrity and human wellbeing. This research's landscape of affordances brings to gether the anthropologic structural characteristics and biophysical structural characteristics of polycentric, peri-urban green spaces and green structures to account for both ecological wellbeing (i.e. ecological integrity) and human wellbeing (i.e. affordances/benefits) simultaneously. This is a key component of this research which is supported within the findings. For example, if it was shown that, generally and predominately, residents utilised PPUIGS to achieve affordances in GS that exhibited Very Clean and Very Managed characteristics and attributes with Abundant Facilities and Features, this would have a negative impact on ecological integrity and biodiversity if these characteristics were incorporated into design, planning and management actions. This was not the case though; residents did not interact with these GS characterstics within this Survey's operationalization. Thus, this reserach's concept of landscape servies, a more comprehensive ecosystem servives which include direct HWB benefits to humans, can be and, per results, was achieved.

The application of the Landscape of Affordances model is far reaching. Not only can the specific structural characteristics be modified to other spatial contexts such as more urban or other countries, but specific recommendations can be incorporated into existing policy and management as well as the design and planning of future green spaces. For instance, in Paisley, where the residents predominately visited GS for psychological HWB benefits, this infers which specific characteristic and attributes contribute to this affordance – 1. A limited GS size which allows the viewing of houses across the GS, a natural shape overall to the GS so that it feels wild and natural and has a sense of ruralness such as woodlands, a GS with four (4) or less edges total, and a GS with a predominately

deciduous vegetation structure to it. As such, it is important to maintain these physical characteristics to provide visitors these preferred benefits such as managing the deciduous trees and shrubs well, replacing with durable and resilient deciduous species, and managing the growth and pruning of the trees and shrubs to be wild and natural (i.e. not heavily manicured or pruned, not planted in distinct rows or lines) (See Figure 11.2).



Figure 11.2

Paisley, Scotland Optimum Psychological –Based Landscape of Affordance Characteristics (Robertson Park)

This research showed that the most visited GS within each CA - woodlands, forests, grasslands and parks - exist in a state of fragmentation with continued impacts from landscape fragmentation and human development to occur. However, he most common eco-spatial characteristics shown to most affect positively HWB and affordances within the CA's overall GS include more edges, more dense edges, smaller and more complex shapes, close or even physically connected to other GS, and with a naturalistic vegetation structure both horizontally and vertically. These GS were also, generally, moderately maintained and clean with a few facilities in them and considered somewhat safe by respondents with only a few well-lit areas.

These results indicate potential future design, planning and management goals for each CA. For instance, results indicate that in order to achieve more

multi-beneficial forests and woodlands in the Vantaa CA, these GS require more facilities and features such as trash bins, benches and restrooms, more lights and signage, and a more moderate level of maintenance so as not to appear unruly and unmaintained. Vantaa's forests and woodlands also should maintain their connectivity to or integration with other GS. The existing edge conditions of many of Vantaa's forests and woodlands currently exist in a state of beneficial affordances (e.g. many edges (8+), dense edges (not transparent) and should be managed to enhance these characteristics (See Figure 11.3). Urban forestry management should be incorporated as well, to facilitate continued ecological-based benefits (e.g. See European Forum on Urban Forestry 2018 - EFUF, Helsinki Finland).




E18
Tapanilankaari
Pavonlinja





Figure 11.3

Vantaa, Finland Fragmented Forests and Woodlands Optimum Landscape of Affordance Characteristics

(Top) Forests with more facilities and features such as restrooms and pathways as well as trash bins, lighting and signage improve HWB affordances.

(Middle) Vantaa's fragmented forests and woodlands currently exist in a connected, integrated state with adjacent and surrounding GS and their edges currently exhibit multiple affordance-providing characteristics such as multiple edges and dense edges.

(Bottom 2) However, their vegetation characterisitcs can be better managed to improve diversity such as more diverse groundcovers and mid-story vegetation in an informal and naturalistic manner yet with moderate maintanence levels so not to seem untidy or usafe.

Furthemore, results indicate that in order to achieve more multi-beneficial grasslands in the Paisley CA, these GS require more facilities and features such as simple shapes (4 or less sides), a vegetation structure with unform horizontal plantings such as grass and groundcover and clustered or clumped vertical trees and/or tall shrubs which, overall feels natural, not urban, and offers extensive

visibility both within and out from the GS, feeling somewhat safe with many spaces and places to socialize with benches and tables or larger areas, and should maintain their connectivity to or integration with other GS. The existing conditions of many of Paisley's grasslands currently exist in a state of multiple beneficial affordances and should be managed to enhance these characteristics (See Figure 11.4).









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Figure 11.4

Paisley, Scotland Fragmented Grasslands Optimum Landscape of Affordance Characteristics

(Top) Clumped vertical vegetation and uniform horizontal vegatation which feels natural can improve multiple HWB affordances (Strathgryfe).

(Middle 2) Paisley's grasslands currently exist in a connected, integrated state with adjacent and surrounding GS and provide extensive visibility with a somewhat safe feeling to them (Both: Glennifer Braes Regional Park).

(Bottom 2) However, their sociability attributes and benefits can managed to improve such as more benches and tables and distinct spaces.

Additionally, other GS within the Vantaa region, for example, can be managed differently to add to the affordances provided. In particular, the GS near Rapakivi Park was predominately visited for Psychological benefits and whose significant GS characteristics included limited visibility so you could not see long or expansively within the GS. In order to increase other affordances such as physical or social, the analysis shows that, for example, one could add a moderate level of facilities such as a few benches, tables, signage, trash bins without negatively impacting the psychological affordance yet increasing the social and physical affordance. However, it is critical that the placement of these facilities

still enact the natural setting of Rapakivi Park – such as placing these elements not in open, grassed areas but more integrated into the naturalistic vegetation of the GS. This technique would also work for Rapakivi Park as there are currenty unpaved paths and though unpaved or dirt paths were not correlated to psychological HWB, they were for Social HWB, thus strategically adding to the planning, design and management of Rapakivi Park with additional PPUIGS affordance characteristics would improve the multi-functionality or multi-affordance of the GS. However, care must be given to ensure no 'negative affordance' characteristics are integrated, such as abundant facilities (i.e. more than a few benches, tables, drinking fountains as well as cafes and restrooms or other built structures) as these would deter from psychological benefits.

Specifically, the Vantaa SQ showed no respondents visited Allotment & City Farms as well as Community Gardens. However, they do exist within the CA, yet these GS were not selected. Why is this? One reason could be they did not provide the desired affordance for the residents or they did not provide a multitude of affordances which many GS offer (i.e. physical and social benefits simultaneously). As such, these GS cold be designed, managed and improved with

A deeper level of analysis could provide specific targets for the regional GS in order to improve their affordance benefits. For example, in Vantaa, the least correlated affordance was Physical benefits and the only statistically significant characteristic was an Integrated GS – a green structure which is part of bigger, physically and spatially (e.g. garden within housing, village green within neighbourhood, playground within larger park) or area within larger green structure (e.g. Regional or Country Park). In order to improve Physical benefits to residents, the design, planning and management of future and existing GS should incorporate GS which have different activities within that larger GS or physically connected GS. For example, a large GS for the Vantaa region should have a playground, football/soccer field or tennis court within a larger park.

This and other similar strategic analyses could be completed with a full GS audit of the PPUIGS characteristics and affordance correlations provided to any GS within the regions of study and, as mentioned, adapted to ther areas of study. This

audit would seek those overlapping affordance GS characteristics, promoting the development of multi-functional GS which provide multiple affordances.

Overall, the Research's Landscape of Affordances applied model through the PPUIGS Index provides a clear representation of those specific eco-spatial characteristics that provide the most HWB benfits to the most people through interaction. This also allows for a more prudent and strategic use of council's/government's money and employees time to increase public use and enjoyment of their GS.

Table 11.1 below summarises this research's contributions.

- Increasing the body of knowledge on polycentric peri-urban regions and their fragmented green spaces and green structures, *particularly their interstitial GS,* and on how this relationship is affected by human development patterns within the urbanisation process (Lit Review).
- Applying an integrated modelling structure, DPSIR, to analyse and synthesize landscape fragmentation and urbanisation within peri-urban, interstitial green spaces and its effects upon human well-being (DPSIR Framework).
- Providing a tested, replicable PPUIGS Characteristics Performance Measurement Index (Table 7.30) specific to peri-urban, interstitial green spaces within a fragmented context that integrates both structural and non-structural attributes of sociological and ecological landscapes and that can be used to measure both ecological integrity and human wellbeing (Landscape Services Index).
- Exhibiting the application of the web-based SoftGIS methodology to collecting qualitative and quantitative data simultaneously as a tool for social science research within the spatial planning and design disciplines. (Methodology)
- Demonstrating a pragmatic affordance-based model (Figure 6.3) which, when activated thorugh SoftGIS, analyses and measures the human-nature relationship based on interaction to investigate and better understand the interrelationships between landscape fragmentation, it's spatial and

aspatial characteristics, individual factors, and human well-being. (Conceptual Integrated Affordance Model + SoftGIS)

- Considering the spatio-temporal forms, patterns and processes of polycentric development that generate fragmentation pressures upon existing 'fringe' green spaces and green structures within the Greater Glasgow Urban Region and the Helsinki Urban Region. (Case Study)
- Demonstrating the importance of PPUIGS, regardless of size and how unkempt, unvegetated, isolated, or fragmented they are, to HWB and how they PPUIGS function as multi-functional GS (Landscape Analysis)
- Reinforcing and adding to the research supporting the suite of human wellbeing benefits provided by green space interaction, particularly within peri-urban and urbanising regions and the synergestic effects PPUIGS provide to HWB. (Landscape Analysis)
- Providing a clear, empirical relationship between fragmented green space characteristics and attributes and those specific HWB affordances (Landscapes of Affordances and Model) within the Paisley, Scotland Peri-Urban region and the Vantaa, Finland Peri-Urban Region which can be applied in other PURs and PolyPURs.
- Disseminating the differences between and among residents' us, interaction and HWB benefits received with fragmented green spaces within the peri-urban areas of Paisley, Scotland and Vantaa, Finland. (Case Study)
- Revealing that certain variables are not important predictors of HWB benefits from GS. (Statistical Analysis).
- Reporting that, contrary to the literature's assumptions and expectations, the fragmentation of interstitial green spaces found in polycentric peri-urban regions of Europe does not, generally and mostly, negatively affect the production of wellbeing benefits to residents. (Statistical Analysys + Hypothesis).

Table 11.1
Summary of Research Contributions

This research has contributed an operationalised comprehensive index of socio-ecological HWB indicators for green structures and green spaces in

fragmented peri-urban regions that can be applied in other studies. The spatial mutuality between the ecological and anthropological characteristics of PPUIGS demonstrated in this study facilitated the synthesis of indicators that combine both qualitative and quantitative aspects of human wellbeing and ecological wellbeing.

A number of authors have noted the need to integrate ecological and human dimensions of wellbeing beyond the singular indicator of biodiversity or a composite of different indexes synthesised into a single integrated indicator value (Dramstad et al., 2006; Farina, 2006; Jongman, 2002). Additionally, other studies have noted inconsistency and variation in indicators (e.g., type, size, and quality or health, wellbeing, etc.) for GS, rendering comparison across studies difficult. This research provides such an integrated index through which to continue study and application.

This research's indicators can positively affect policy and planning within Europe; but this relationship needs development and support. This research is but a step in that direction to integrate both qualitative and quantitative indicators of both the social and ecological aspects of the urbanisation process and their effects on GS and ultimately, human quality of life.

11.3 Research Strengths and Limitations

The robustness of the results of his thesis are found within the strength of the PPUIGS eco-spatial characteristics relating to specific HWB benefits, as achieved through affordances or transactional behaviour. This research's mixed-method, multi-method strategy supports two important research concepts: triangulation and complementarity. When descriptive indicators are applied alongside quantitative indicators, as in this study, data reliability and validity can be enhanced.

Although a set of strong applications and indicators exist to measure both urbanisation and landscape fragmentation, they are often density based and/or ecological based, and overlook the socio-cultural and socio-ecological changes evident within the landscape (Van Eetvelde and Anthrop, 2004). Even though there is a general agreement about the negative ecological effects of landscape fragmentation (e.g. Fahrig, 2003; Zeng and Wu, 2005), the interactions between the

biophysical and anthropogenic factors are still poorly supported in the literature. The results of this study adds to a growing body of work regarding HWB within the application of socio-cultural or human-based indicators.

11.3.1 Data Validity

This research's strategy provided both ecological validity and external validity, to the best degree possible, within its unique context. Additionally, there is strong data validity in the data analysis. Although the CATT provided a higher 'power' level than the chi-squared test, this was only when the suspected trend is correct, since the CATT was less effective at detecting non-correct trends. The CATT was deemed appropriate, however, given the context of the research objectives and post-hoc data manipulation. Additionally, the CATT did not affect sampling distribution and null-hypothesis detection.

In achieving validity, this research is both hypothesis and descriptive driven. The methodology's quasi-experimental, explanatory, approach revealed eco-spatial relationships. Yet the hypothesis testing provided only partial insight into the larger relationship between humans, PPUIGS, landscape fragmentation and wellbeing; the utilisation of an exploratory approach was required to answer the study's interdisciplinary research questions effectively. In addition, the output of GIS maps removed the subjective interpretation and speculation of the viewers. GIS maps will also help bridge professional, educational and experiential differences in viewers, and within discussions, by providing factual, concrete data and imagery, moving towards a common perception and medium in which to discuss pertinent issues. The data and results have certain aspects that are considered highly generalisable, and which can be extrapolated to other PPUIGS' communities and regions within Europe.

11.3.2 Data Interaction

The strength of this multi-method data collection technique is that it allowed for significant interaction with the data. Datasets were statistically analysed, where applicable, both individually through ArcGIS Spatial Analysis and SPSS Software and collectively through an integrated statistical analysis of multiple datasets.

This research utilised both subjective and objective measures of HWB in order to capture its multidimensionality within the socio-ecological context of PULs. This mixed method approach (Creswell, 2003) to assess HWB is supported within academic research (e.g. Camfield et al., 2009; McGregor, 2004) and it has been noted that integrating data from qualitative and quantitative approaches strengthens its explanatory power. The subjective and objective components were measured independently within this study.

11.3.3 Sampling Strengths and Limitations

Previous research has examined GS usage patterns generally through questionnaire surveys. More often these are conducted on-site for individuals and less so for household-based questionnaires. As with any survey, the quality and relevance of the questionnaire design influences data analysis and validity (Bell, 1999). The use of SoftGIS in this research, however, removes many typical limitations within questionnaire and survey-based data collection. Environmental psychology lacks a physical setting; thus the environment is lacking in the relationship where both are active participants. SoftGIS was developed as a means to collect and record reciprocal, location-based information – here HWB affordances. Nevertheless, it is important to note that this study's post-hoc SQ results do not explicitly link behavioural interaction to benefits; human variability and perception affect GS interaction (e.g. Frumkin, 2003).

The main benefit of utilising the SoftGIS SQ in data collection is the explicit connection maintained with the context of which particular affordance or benefit is linked to which specific GS as per it geomarker. Another key advantage is that the data provided by the residents can be related to the abundant register-based GIS-data concerning the built environment; the area and population densities, land use patterns and many other layers. This research only utilised those datasets required to answer the research questions.

SoftGIS can be used to measure the social values of residents in relation to GS and to inform decision-makers and planners in an appropriate map form that is familiar to professionals and easy to work with (Tyrväinen, Mäkinen and Schipperijn, 2007). This tool is suggested as a useful aid in participatory design and

decision-making for many planning and design professionals.

Prior studies have identified potential drawbacks when utilising SoftGIS, however (Brown and Weber, 2011; Kahila and Kyttä, 2009; Raymond et al., 2009), including a low response rate due to the internet-based participation methodology, although not necessarily specific to SoftGIS applications.

The sampling frame primarily utilised a web-based, 'viral' distribution approach common within social media in order to gather a wide sample size within the digital-based SoftGIS SQ. The efficacy of this approach is estimated in Appendix 6. Although this was an efficient and effective means to gain a sampling set, the disadvantages are self-evident and may exclude some important cases from the population. Being web-based, the data collection was purposefully 'iPad' or 'tablet' friendly in its design and HTML structure, thereby facilitating responses. The design of the SQ was also simplified in order to increase sample size.

The robustness of the sample data from the survey questionnaire was considered and discussed but no analyses were conducted concerning respondent bias or other influences, since sample sets were distributed evenly. Additionally the secondary data was synthesised from datasets from two different years (2014 and 2015).

The samples were not equivalent samples, but they were carefully and deliberately chosen – both geographically and methodologically. Each sample-set was not a cross sectional or selected sample, but it was not a completely random sample either. The probability sampling results are limited to the geographic location (i.e. morphologically polycentric, fragmented peri-urban region) and web-based nature of the SQ, particularly in regard to who was able to receive the invite to the SQ (i.e. the SQ requested participants 18-65 only, thereby excluding young adults and older individuals, noted users of GS). Additionally, of the three distribution methodologies listed, the council members were accessed only for those within the region of study and their constituents. The SQ invite was forward to as many government/municipal employees as possible, as listed on current websites, with requests that the link be shared with other employees. The Facebook pages were limited to outdoor/nature/child/recreation/dog/leisure pages that could

be accessed. In this regards, there is purposive or deliberate sampling by the researcher.

Concerns over sample size reliability (i.e. effect size) and inference or representativeness to the larger population are valid, as this was also a small sample. This is to be expected, however, since spatial-based research inevitably limits survey respondents geographically. Lastly, and importantly, within this research's limited sample size, it is inferred that a larger sample size would result in statistical significance. Small sample sizes often do not yield statistical significance; but when they do, the differences themselves tend to be practically significant; that is, meaningful enough to denote discussion and, in this research, action.

11.3.4 Limitations in the Measurement of HWB Benefits

There are many factors that may affect the reception of HWB benefits within a PPUIGS besides eco-spatial characteristics. Just as there are many unaccounted potential mediator variables that could affect affordance benefits results or those HWB benefits reported. The variability found within individual-based sampling research is known, and limitations to this particular data were discussed previously.

The indirect relationships between PPUIGS and HWB, those extraneous variables within this research, include a wide range of issues and concepts. Within the biophysical landscape, factors may fluctuate within the same block or same neighbourhood, and include the degrees of fragmentation within the variables. Within the socio-cultural landscape, the interpersonal, demographic, ethnographic, and socio-economic factors are many and include personality types, ability to achieve HWB elsewhere, as well as individual mental and physical capacities and existing state of HWB and LS.

There are probably other attributes of PPUIGS not captured through this research's eco-spatial model that may nonetheless influence HWB affordances. On the other hand, this research's broad approach provides a good generalisation of what types of GS, with what particular eco-spatial characteristics, are used for what particular HWB benefits. This research assessed the HWB benefits individually,

however, and was unable fully to account for multiple factors or integrated mechanisms impacting HWB – i.e. the synergistic effect of GS interaction and HWB. Other concepts of multi-affordance GS have been documented in research (e.g. Korpela et al., 2014; Peschardt, Schipperijn and Stigsdotter, 2012).

The study tried to differentiate between the various types (i.e. green structure typologies and groupings of characteristics) of GS so that simplified assumptions about all the GS being 'similar' were acknowledged. The reality, of course, is that these different types of GS are used quite differently by different residents (Chen and Jim 2010; Lindsey et al., 2001). For example, families with young children might have more interest and use for smaller neighbourhood parks with playgrounds and no particular desire to use hiking trails. With young children, a shorter distance may also be important to consider. Culturally, nearby access to, and use of, GS may not be considered important or undesirable for cultural green space requirements. This human-based, functionally-driven and motivationally-driven use of and interaction with GS is not fully represented within this research's results.

Overall, this research's analysis concluded that the effect of demographic variables and socio-economic status on the attainment of HWB benefits from PPUIGS interaction was ambiguous, thereby reducing the validity of conclusions extrapolated to the larger population, specifically urban residents and rural residents. Larger sample sizes and, perhaps, better defined wellbeing variables are required to investigate the impact of these socio-cultural and socio-economic variables on the various aspects of HWB as related to interactions with PPUIGS.

11.3.5 Limitations in Respect to the Sampling of Life Satisfaction

The prevalent theory in respect to LS and HWB is that it is a relative relationship. In this regard, LS is a solely cognitive-based concept, unaffected by experiential actions/reactions. Yet within the concept of human functioning and the idea of meeting basic needs, LS is not relative; needs are absolute (i.e. needs satisfaction). LS thus involves perception and behaviours. This transactional aspect of LS and wellbeing allowed for the theory of affordance to be the theoretical

paradigm and measurement tool in this research's assessment of HWB as a construct of LS.

The limitations to any self-reported LS ranking are well documented (see Veenhoven, 2008), the variables encompassing subjective wellbeing and LS are multi-dimensional, complex and interrelated. Any subjective measurement, particularly LS as it relates to HWB, will have contextual variances. Within modern society and contemporary culture, personal traits and theory can only explain some of these variables.

The overall self-reported higher life satisfaction result in the Vantaa CA may be due to the GS spatial arrangements reflective of the polycentric development pattern of the region. This research does not clarify that relationship, mostly due to the high number of extraneous, mediator and moderator variables present. Furthermore, the relationship from a self-reported LS level to HWB is tenuous within this research's structure and must be improved in future research. Nonetheless, this research's data and results are verifiable.

11.3.6 Limitations in the Case Study Analysis and Comparison

Overall, case studies have limitations including validity, reliability and generalisability. Case studies were operationalised in this research primarily as an exploratory tool and the two-case study approach focused on comparative analysis and not statistical generalisation, though there is some degree of statistical comparison to be had.

It can be argued that this case study analysis might only be applicable to UK and European PolyPURs given the myriad of contextual factors. Yet, HWB and the many landscape facets included in this research are universal, and the means to achieve those benefits through the landscape's PPUIGS characteristics were devolved to such an delineated, schematic level that both the affordance based methodology and the PPUIGS Characteristic Performance Indicators can be applied in almost any context, although modifications to those eco-spatial attributes and levels specific to affordance would be required.

11.3.7 Summary of Research Strengths and Limitations

In summary, the number of potentially confounding variables is large. The

human-environment relationship is complex. The interpersonal factors which cause, or do not cause, interaction such as motivation with GS and the receipt of HWB affordances is difficult to quantify. There are many diverse reasons for this that may include social exclusion, stigma, fear and other cognitive factors that are hard to define and measure clearly and consistently. These and other individual cognition and perception factors are referred to as 'anthropic filters' and influence GS interaction. Overall, the individualistic variables found within GS interaction and HWB are complex and considered too anecdotal to provide clear evidence (Morris, 2003).

As stated, ecological and natural sciences research has denoted what are the 'preferred states' of landscapes and GS to provide certain benefits or 'ecosystem services' but little evidence exists on the 'preferred state' of fragmented PPUIGS to provide human-based benefits. Additionally, there is no consensus on the most functional PPUIGS form or attributes to provide these HWB affordances. Although this lack of empirical evidence, and agreed upon PPUIGS benefits, is mostly due to cross-cultural services and individual value preferences, this research is social-science based, and thus normative and hedonic considerations were purposefully excluded in the discussion. Notably, however, in the context of policy response and spatial planning actions, the HWB interaction factors and PPUIGS characteristics utilised in this research were specific and spatio-temporal; facilitating a quasi-integrated (i.e. socio-ecological) model on which to test the hypothesis and measures.

All data requires interpretation, regardless of external and/or internal influence (Keat and Urry, 2011); this research has collected, synthesised, and interpreted the data objectively and effectively. As stated by Cohen et al. (2007, p461), "*there is no one single or correct way to analyse qualitative data…it should abide by the issue of fitness for purpose"*. Overall, however, the data collected and synthesised, as well as the methodologies utilised in this research, enrich the development of the evidence base in the social sciences including environmental psychology, public health, spatial planning and landscape architecture. This research has empirically shown that human interaction with the landscape and its

PPUIGS is dependent upon its eco-spatial characteristics.

11.4 Implications for Policy, Spatial Planning and Landscape Architecture

Interstitial green spaces – those GS situated between and among the polycentric urban centres of Europe's rapidly urbanising regions – are minimal, fragmented and vulnerable to further fragmentation. Opportunities to create new GS within these areas are insufficient and infrequent. These PPUIGS are often characterised by low ecological quality, yet, as shown, they provide diverse and unique HWB benefits not found elsewhere in other GS and morphological patterns.

A planning issue of importance in many PULs is how to arrange areas of natural land cover spatially within the human-dominated matrix. The changes and variations in landscape patterns and processes indicate the transition from one state of a scale to another. Ecological, as well as socio-cultural, processes would take too long to observe within the timeframe of this dissertation, and thus this research is just a snapshot, a temporal depiction, and the importance of selecting an appropriate geographical area, methodology(ies) and focal variable(s) which exhibited both existing and emerging urbanisation characteristics and interstitial GS was critical.

The results of this research do not indicate that the more diversity of PPUIGS characteristics a PolyPUR has, the better it can serve its varied residents. There were consistent and statistically significant typologies and groupings of characteristics that provided for both a variety of and specific HWB benefits. As such, this research can assist in future decision-making and policy initiatives within PolyPURs facing landscape fragmentation pressures. The research's results begin to suggest that better provision of slightly formalised, managed, interconnected GS may encourage greater levels of socio-cultural HWB benefits for life satisfaction and overall QOL. Strategic planning, such as greenbelt initiatives, green network planning, infill planning and management strategies can all learn lessons from this study. It is shown that natural, wild, disconnected landscapes are not the best for most HWB benefits within PPUIGS contexts, although they do have certain ecological service benefits (e.g. biodiversity). Landscape services and the tenets of a comprehensive, multi-scalar green infrastructure (i.e. ecological green

infrastructure and socio-cultural green infrastructure) support both ecological interests and human interests together.

The relationshiop shown between affordances and landscape services prompts designers to think about landscapes as arenas for functional action. Yet it also creates opportunities to integrate aesthetic experiences in landscapes and GS, facilitating multi-functional landscapes. SoftGIS and PPGIS can incorporate user actions, as well as perceptions, and when combined with other data, can reflect both social and environmental functions. In this regard, affordances provide a type of evidence-based design, effectively subdividing GS and their eco-spatial characteristics transactionally (i.e. behaviourally) so that they can be linked to guiding design interventions.

From the perspective of residents' wellbeing and LS, planners and designers of GS need understanding both socio-culturally shared meanings, and subjective experiences bound with exact places (e.g. SoftGIS geomarkers thru SQ). This research provided such information and has applications across many spatial contexts. In this research, the data reported what kinds of PPUIGS (i.e. what eco-spatial characteristics) are, generally and typically, specific to the provision of HWB benefits – thereby representing a communities overall values of GS. If other studies in other communities, for example, show that psychological HWB benefits were the lowest when interacting with GS, then a response would be to provide more GS with those specific and unique eco-spatial characteristics and attributes reported within that region, or to modify management and design strategies to reflect those GS that better enable psychological HWB affordances. This decision would require further evidence, including the preferences and perceptions of engaging with PPUIGS and a clarification of values, however, this research provides a solid platform to continue such study.

Environmental psychology, landscape architecture and spatial planning can benefit from utilising an affordance perspective to the design of GS, since the evolving terminology within this paradigm avoids unclear terminology (e.g. complexity, coherence), overly technical and abstract design concepts (e.g. sustainable, eco-sensitive, healthy community) by focussing on the benefits specific

to the properties and physical attributes of GS. This affordance perspective also clarifies analysis and research measures. For example, instead of focusing on the materials, size and shape of elements within a GS or common area of a housing development, the characteristics discussed should focus on the functional significance of the GS, or the HWB benefit for individuals who would probably interact with the space. This affordance-design perspective does not focus on actions or activities such as running, resting, playing or socialising, but rather the potential affordances to a wide group of potential users (e.g. young children, the elderly, adults, teenagers, etc.). Heft (2010) referred to these qualities as 'functional meanings' which evolved from Alexander's work (1977). The design of GS in this way provides highly performance-based landscapes, i.e. landscapes that are multi-dimensional, multi-functional, multi-cultural and serve multiple purposes (i.e. synergistic). As noted by Heft (ibid), this pluralistic perspective moves beyond individual interpretation, focusing on the more direct possibilities for wellbeing within the individual GS interaction or human-nature relationship.

Landscapes of affordance are thus potentially important for landscape architects and designers. Not only can a transactional approach to design serve to bridge the designer-user gap in communication, thereby creating empathy with users, but affordance-based elements within the landscape – natural or anthropic – can expand design-intent, since users will perceive and utilise elements in diverse and novel ways. In environmental psychology, landscape architecture and spatial planning, user needs are a prevalent topic of study. For example, Maier and Fadel (2003) proposed Affordance-Based Design (ABD) as a way of overcoming the weaknesses of the Function-Based Design found within the engineering sciences and product design, thus using the synergy between affordance and function-based approaches to create better design.

In recent years, the functional significance of affordances has taken on an expanded meaning. "Function" need not be limited to what one can do as an individual in relation to an environmental feature, but can be extended to what one can do as part of a group (Heft, 2001; Marsh et al., 2006). Furthermore, it is plausible to explore not only what the individual does, but also what an individual

feels in the course of acting alone or in a group context (Kyttä, 2003). In all cases, however, the socio-emotional dimensions of engaging affordances need to be tied to specifiable properties of the environment.

Affordances are essentially about function. In the landscape, it is the human-nature relationship that creates the possibility for action and affordance. Affordances do not cause action, however: there is no environmental determinism. Rather, affordances identify possibilities for action, as well as constraints on action. The goal of designers is, to a degree, to make affordances perceptible. Although it may be impossible to analyse affordance-based research empirically, narrowing the spectrum of perceived affordances down from a vast array of eco-spatial characteristics or elements is an important step in that direction. This research did not show any specific eco-spatial PPUIGS characteristics as being strong predictors of affordance-based behaviour, but this does not preclude utilising such an approach in the future with reduced variability.

The socio-ecological landscape is a physical, spatial construct. This provides a means to address interdisciplinary research and applied theory. Academics and scientists within landscape architecture and the design disciplines need to develop more practice-based research and focus on developing operational tools. Accordingly, they need to become more familiar with planners' goals and policy instruments in order to integrate their respective disciplines more effectively.

11.5 Implications for Future Research

Land use fragmentation through urbanisation is a threat not only to ecological systems but social or human systems as well (e.g. Matsuoka and Kaplan, 2008). Planning frameworks have recognised the distinct need to respond to these threats through integrated planning approaches.

Overall, this research has provided a replicable methodology that can be applied within many concepts. The theory of affordance provides the theoretical foundation to assess the experiential or intangible benefits found within the transactional process of the human-nature relationship; here, HWB and PPUIGS. Future research will require further integration of the natural and social sciences (Bell et al., 2007) and may include models that describe the underlying drivers of

polycentric urbanisation and landscape fragmentation, and the functional linkages between the delivery of landscape services and HWB.

FRAGSTATS has been developed for and heavily utilised within the ecological sciences, not the social sciences. Though the relationship between this research's metrics and ecological processes is mostly understood, it is much less so regarding anthropological and HWB impacts. This research adds to this dialogue.

The FRAGSTAT analysis served to provide a relative measurement of how connected the landscapes of study are. It relates the degree of fragmentation found within the areas of study. FRAGSTATS served as an effective tool within the overall methodology to study fragmentation and captured the important properties of interest within this research at the appropriate scales. FRAGSTATS, combined with the other analytical procedures, serves to describe the extent and pattern of landscape fragmentation. Though the exact mechanism of landscape fragmentation may be not be explicit within FRAGSTATS, these results serve to support other, similar research studies. For instance, these metrics can be utilised in future longitudinal studies. How has the region's fragmentation characteristics changed in 3 years? 10 years? 25 years?

A longitudinal study may provide valuable information for this research's area of study, though this would be difficult. The benefit of this approach would be the provision of spatial mediation in a pre- and post-analysis. For instance, a GS could reduce vegetation management in order to increase its semi-natural or natural regulation, or provide an increase in facilities, features and lighting. Individual variability would still be prevalent, but this sort of study could, potentially, strongly assess the effects of affordance-based design.

This research would have benefitted from a pre- and post-analysis survey within the specific GS in order to better understand the actual HWB impact upon interaction. Human actions vs. human intentions are often quite different; affordance-theory as applied to human behaviour includes subjective expectations that must be acknowledged in the research process. For example, an interview or survey conducted at a GS which provided a diverse set of HWB benefits (i.e. not just predominately psychological) would more accurately and directly provide

HWB benefit data. Additionally, neurological metrics could provide insights into specific HWB benefits received from GS interaction.

Perhaps a more detailed and intense study of a specific multi-functional, highly visited GS could provide data not attained through this research's methodology. Relationships to GS characteristics would be limited to those present, however, and thus specific to those users of that particular GS, and accordingly not fully randomised. A behavioural analysis within a GS study would, however, reduce respondent bias and other survey data contaminants, but accurate coding of behaviour to ensure validity would be difficult to achieve. Extended interviews, guided walks and other kinds of participation-based methodologies of research afford the benefit of contextualising the research in situ.

Although this research did not measure behaviour, an in-situ task-oriented study focussing on specific HWB benefits afforded through behavioural interaction could be requested within a specific GS. Activities and behaviours could be monitored, as well as a set of biometrics including cortisol and neurophysiology among others. Not only would this approach begin to provide a scale-based metric to affordance activities (i.e. intensity) within the GS, but it would also provide quantitative support to the findings. This potential study could also be directed by requesting an affordance task within the GS of study, thereby providing insight into the eco-spatial characteristics of HWB benefits, and eliminating other behaviours whose influence could be misconstrued. Any such direct-behaviour study would add to the information that supports designers, planners and managers in their evidence-based design and affordance-based design processes. For example, the research concludes that there are specific and unique eco-spatial characteristics within the studied PPUIGS not found within other morphological configurations, but it is not clear whether these PPUIGS provide HWB benefits not found within other GS and morphological assemblages.

The notion of environmental or spatial determinism pervades behavioural theory. In the context of this research, this raises the question of whether the characteristics of the GS dictate the interaction, or whether the intended interaction is fulfilled by the GS, where the GS can be of many varied eco-spatial qualities.

Although such determinism has been removed to the best possible degree from this research's methodology and analysis, it has not, however, been removed from many spatial planning, policy development, and design disciplines. It may be that landscapes of affordances bring about an environmental possibilism or probabilism (Dempsey, 2009) in a two-way, dualistic transactional perspective.

It would be important to conduct this research and data collection with other geographically determined residents – distinctly urban or rural – to determine if they achieve the same affordances from similar eco-spatial characteristics. Would urban residents, for instance, seek out PPUIGS in order to achieve a specific HWB benefit? The evidence for the health benefits of UGS is limited. Further research needs to address aspects of availability, existing ecological conditions, location, and accessibility of GS, in addition to more accurate socioeconomic status, race and familial factors. Furthermore, there is no universal standard as to what is considered GS, or what characteristics such a space is required to have before it is considered to be an "urban green space" or "rural green space," resulting in limited classification and contextualisation.

Altogether, there are many directions through which this important research can move forward. One is further study and analysis of the concepts and themes presented herein: affordance-based HWB through GS interaction. For example, the literature has well documented the psychological wellbeing relationship to GS, and the benefits of mental restoration and reducing mental fatigue. This previous research, however, is largely focused on natural environments and their associated non-demanding mental interaction as the means to achieve psychological wellbeing. As noted by Thwaites (2013), this benefit is often difficult to achieve in urban and urbanising landscapes. Yet psychological wellbeing is a diverse, interconnected concept within HWB, including concepts of self-worth and self-esteem – aspects that often require a more active interaction with landscapes, and not those necessarily 'natural' and static (Thwaites and Simkins, 2007). The PUL is a hybridised-landscape exhibiting not only many socio-ecological attributes but also the various states within them.

The other complementary direction that this research could move towards is a

more explicit understanding of the multi-functional affordances GS interaction can provide. For example, future research into landscapes of affordances can expand the socio-ecological perspective to in-situ behavioural observations. This is highly recommended and can include archival video or post-use video analysis. If behaviour is assessed and coded in-situ, direct feedback at that moment through an individual interview (Heft, 1998) is recommended to reduce affordance benefit misconceptions, although Kyttä et al. (2004) has commended retrospective feedback.

Perhaps not surprising, research has indicated that GS HWB benefits are interrelated, with each of the three constructs supporting one another and interacting to facilitate benefits – they are synergistic. For example, physical health can be increased through strong social wellbeing (Uchino, 2006). Psychological wellbeing is shown to be more positive with strong social networks (Umberson and Montez, 2010). Physical and mental wellbeing are both components of positive GS interaction where access, physicality and mental restoration operate together. Jacobs (1961) demonstrated the correlations between human health and social interaction. Empirically, economists have also been able to show a strong correlation between trust between citizens and economic growth (Knack, 1997). Fan, Das and Chen (2011) concluded that parks *"directly promote physical activity, and indirectly mitigate stress via the spaces' positive impact on social support"* (p. 1209). Similarly, walking, cycling, and other outdoor sports or activities have been shown to improve both physical and psychological wellbeing (Browne, 1992; Davis, 1999; Countryside Agency, 2000) and spiritual health (Hickmann et al., 1999).

The results show that many eco-spatial qualities provide many different transactional HWB benefits, but these are not as varied and widespread as one might think: specific PPUIGS characteristics provide specific HWB benefits through interaction across this research's sampling. In this regard, future research should consider how to capture combinations of interactions that affect HWB benefits more effectively, i.e. the synergistic effect of PPUIGS interaction. For example, it may be that physical activity with friends or family in a GS provides

psychological HWB benefits. This research structure did not account for this concept completely.

This research has only touched upon many important concepts that require further study and analysis in order to support firm conclusions. As the configuration of GS is better understood within PolyPURS, in the context of anthropic activities, this research begins to elucidate optimum landscape structures for both ecological integrity and the benefit of HWB and quality of life.

But what is it about qualities in the fragmented landscape which lead to HWB affordances? And why do some individuals chose to interact with GS in certain ways and others not? Are we 'needs based' organisms? From an evolutionary perspective, some affordances are more important than others (e.g., Withagen and Chemero, 2009). Kyttä (2004) pointed out that affordances may be positive – they are opportunities within the landscape – or they are negative, i.e. they are dangerous landscapes.

Negative Affordances

What this data does not identify are the PPUIGS characteristics, attributes and levels that cause individuals to not interact with them – such as deep, dense, dark forests or unsafe facilities. Additionally, within the concept of negative affordances, what are those eco-spatial characteristics that cause negative HWB such as stress, fear and poor health? It would be wrong to assume that a GS not identified by any respondents contains negative HWB affordances. Although the lack of interaction with a GS may be based on the limited SQ structure (limited geomarkers), there may be other factors not accounted for, eco-spatial or otherwise.

A negative affordance is not simply the opposite of a positive affordance; and neither occurs until an actual interaction occurs.[33] For example, dark forests and poorly managed parks have been reported to cause fear (Lyytimäki et al., 2008; Skår, 2010), yet danger and the heightened emotion of uncertainty can be appealing to certain individuals, and people may want to take conscious risks and test their

[33] Miller et al. (1998) note that an environmental demand does not include choice, and thus is not an affordance. For example, a rocky ledge above a river may provide a recreation affordance if jumped from, but when a charging lion is approaching, it ceases to be an affordance and is a necessity.

skills within PPUIGS. Few studies have focused on negative affordances, however

Nested Affordances

As supported by Gibson (1979), affordances are perceived through action, and the perception of individual affordances is included within the activity itself. This is referred to in this research as the Field of Action. In this regard, affordances may be considered in future research as sequential and nested units (Bærentse and Trettvik, 2002), similar to concepts of ecosystem services and scale-dependent benefits. For example, an affordance may not even become available until another affordance is achieved or GS interacted with (Kyttä, 2004).

This notion of nested benefits can be carried forward into GS research on multi-functional and performance-based landscapes where GS are viewed not through measures of ecologically large or small but human usability and accessibility (Chiesura, 2004). Although this research has provided an effective methodology to identify characteristics and potential causal benefits separately, landscape research will probably continue to view benefits from a 'package' viewpoint that includes people's health, aesthetics and preferences in respect to their effect on HWB and QOL.

Wellbeing is a distinctly anthropocentric view, similar to that of ecosystem services, and within the current understanding of the landscape as a socio-ecological system, it makes sense to pursue research from this affordance-based, utilitarian perspective. The landscape services concept (Termorshuizen and Opdam, 2009), evolving from ecosystem services, is linked to HWB. Hence, the proposal of any service or benefit requires significant relationships between ecosystem and landscape structures and the provision of those human benefits.

11.6 Concluding Comments

Since the mid-1990s, ecosystem thinking has broadened to incorporate humans, not just as outside disturbances but as integrated with other biological and physical processes and structures (McDonnel and Pickett, 1993; Collins et al., 2000; Grim et al., 2000; Alberti, 2008). The landscape will always have multiple, and often conflicting, interpretations due to the multiplicity of interpretive frameworks and continued disciplinary objectivity. These ideological paradigms,

however, perpetuate the interdependence of anthropological systems and ecological systems within transdisciplinary research.

Any one definition or theoretical paradigm to a landscape, or solution to spatial planning, faces uncertainty. This research's definition will not apply within other research constructs, nor is it intended to; but it is the goal of this research to find the 'best meaning' and 'best answer and solution' to these queries presented herein. Perhaps it is not possible to describe adequately the concept of landscape.

Overall, the PolyPUR landscapes of this study exhibit the current state of this interplay between the socio-cultural (anthropocentric) aspects and biophysical aspects of these interrelated systems – it is a transitional landscape. Transitional in this context refers to their entropic and changing land uses through future urbanisation. This will occur through PUGS and rural land uses transitioning to industrial, infrastructural and residential development. New land uses replace older ones – thereby improving the functioning of the landscape for humans. New landscapes evolve thereby providing new landscape services. Landscape, thus, reflects the relationship between humans and nature, or people and place. The interaction of natural components and anthropogenic patterns creates unique contexts to conduct research. As several authors have suggested, coupled human-ecological systems cannot be defined either as humans embedded in an ecological system or as ecosystems embedded in human systems (Westley et al., 2002, Walker et al., 2004). A hybrised landscape perspective and the DPSIR model provides an integrated framework for viewing actions and mediations upon the landscape. Socio-ecological landscapes are inherently connected, and the benefits provided by each are dependent upon the structural functiality and integrity of the others.

Peri-urban areas are the most prevalent spatial typology in Europe's expanding landscape. The dominant land-use frameworks, and biophysical typologies in Europe have been determined by its socio-ecological structures. Human development patterns have fragmented the natural landscape while at the same time integrating complex social networks over multiple scales and hierarchies. These emerging hybridised territories, most commonly referred to as peri-urban landscapes, are opportunistic and adaptive, socially heterogeneous,

interdependent, and enable interaction between the social (urban) and ecological (natural) systems present. Most importantly, it is these peri-urban landscapes, and their interstitial GS, which 'bind' these fragmented spaces together, creating a unique, often overlooked, typology.

As a conduit and provider of beneficial landscape services beyond traditional ecological derivatives, polycentric peri-urban regions, and their associated green spaces and green structures, have generated a deserved identity to themselves. As culturally induced systems, PPUIGS enhance the overall landscape integrity of the region, ensuring the performance of both social and ecological structures.

As shown, the relationship between humans and the landscape is largely dependent upon the form and spatial qualities of the landscape. Each landscape, whether remotely rural or distinctly urban, provides a diverse and unique array of physical features that in turn can lead to certain benefits to the individual. The polycentric peri-urban, socio-ecological landscape provides a space where physical activity can take place; social contact is made possible or enhanced; and there is a psychological response to perception and interaction. This research has illustrated how the physical and eco-spatial qualities of green structures and green spaces in the landscape affect how humans interact with them in order to achieve such benefits. How individuals interact with GS in each spatial context has implications, not only in terms of choice and the theoretical framework of human wellbeing affordances, as described, but also for the planning, design and management of these landscapes.

This research provides important insight into the future development and growth management of polycentric urbanising regions and cities. This research presents one framework for assessing and implementing planning and policy which accounts for humans and ecological integrity within the human development process. Building upon the ecological-based tenets of green infrastructure, polycentric urbanisation can begin to apply multi-functionality more quantitatively and administer more comprehensive measures for performance-based landscapes.

Landscape fragmentation will continue within PPURs. However the

quality or type of GS fragmentation which occurs through urbanisation can, perhaps, be more proactively managed and planned. Additionally, each PUR of study has unique potential recommendations. Certain aspects of the results such as GS, accessibility, GS use and GS management imply potential considerations within their policy and planning disciplines. Overall, a new type of green infrastructural policy can evolve, where ecological integrity and human wellbeing are concurrently considered and actively designed and managed within the spatial planning process. For instance, results indicate, overall and generally, GS fragmentation characteristics of dense edges provide social HWB benefits to Paisley residents. Can interconnected, naturalistic, proximal GS then be designed with dense edge characteristics? Perhaps so."

Landscape planning often involves decisions about the spatial arrangement of conflicting land uses and contradicting demands that influence the level of landscape fragmentation. Spatial planning practices must evolve and adapt to support an integrated approach towards GS within these urbanising landscapes in flux in order to solve the complex sociological and ecological concerns resulting from constant economic and socio-cultural pressures. Landscapes of Affordances, as an applied concept of landscape services, and illustrated through this research, provides such a theoretical conduit to acknowledge and improve these complex and dynamic relationships between humans and their environment. Acknowledging the multi-functional aspects of these PPUIGS is a critical first step; this research has provided a successful, applied methodology and suggestions to conduct further study. Throughout history, humans have manipulated the landscape to provide its highest functionality for QOL and HWB - humans create affordance opportunities – humans produce mediated affordances - thereby initiating a Landscape of Affordances. This can inform urban grown and spatial planning, even management of these GS. These PPUIGS may provide HWB benefits simply because of their access to diverse, heterogeneous characteristics and thus varied opportunities for interaction.

This research, generally, acknowledges that, contrary to the biophysical-based assumptions in respect to ecological integrity in the literature, certain aspects

of landscape fragmentation are beneficial to the provision of HWB benefits to humans. Landscape fragmentation within polycentric, peri-urban regions often include better infrastructural connections and access to important anthropocentric services such as health care, emergency treatment and food shopping, among many others, which are often considered within basic metrics of Quality of Life, to varied residents such as the unemployed, older people and young families. Thus, landscape fragmentation and its impacts upon peri-urban green spaces and green strucutres within polycentric regions may have a positive influence on one's wellbeing. This result is not surprising within contemporary society and the emerging lifestyles of humans. Humans are a fragmented species – we are but pieces of history and memories. Culture, too, is a deeply fragmented concept – and so too is the landscape we thrive in.

Bibligraphy

(EVA), E. V. 1999. Suomen uusjako, raportti aluekehityksestä ja sen vaikutuksista. Helsinki, Finland: EVA Elinkeinoelämän valtuuskunta.

(MOHURD), M. O. H. A. U.-R. D. O. T. P. S. R. O. C. 2002. Standard for classification of urban green space. China.

A.S., B., RAFFESTIN, C. & REYMOND, H. 1980. Les concepts du paysage: problématique et representations [The concepts of landscape: Problematics and representations] *L'espace Géographique***,** 277-286.

ABEL, T. 1998. Complex adaptive systems, evolutionism, and ecology within anthropology: interdisciplinary research for understanding cultural and ecological dynamics. *Georgia Journal of Ecological Anthropology,* 2**,** 6–29.

AGENCY, U. E.-E. P. 2006. Level III ecoregions of the continental United States. Revision of Amernik, 1987 ed. Corvallis, Oregon: USEPA-National Health and Environmental Effects Research Laboratory.

AGRAWAL, A. & GIBSON, C. 1999. Enchantment and disenchantment: the role of community in natural resource conservation. *World Development* 27**,** 629-649.

AHRENTZEN, S. 2008. *Sustaining Active-Living Communities over the Decades: Lessons from a 1930s Greenbelt Town*.

AITKEN, I. 2012. Human Environments: Urban Change. A Case Study of Glasgow. Glasgow, Scotland: Education Scotland.

ALBERTI, M. 2005. The effects of urban patterns on ecosystem function. *International regional science review,* 28**,** 168-192.

ALLEN, A. 2003. Environmental planning and management of the peri-urban interface: Perspectives on an emerging field. *Environment and Urbanization,* 15**,** 135-148.

ALLEN, T. & HOEKSTRA, T. 1992. *Toward a Unified Ecology,* New York, NY, Columbia University Press.

ALM, E. L. 2007. Urban Green Structure – a hidden resource. *In:* WLODARCZYK, D. (ed.) *Green Structures in the Sustainable City.* Brussels, Belgium: The Baltic University Press.

ALONSO, W. 1964. The historic and the structural theories of urban form: their implications for urban renewal. *Land Economics,* 40**,** 227-231.

ALTMAN, I. & ROGOFF, B. 1987. *World Views in Psychology: Trait, Interactional, Organismic, and Transactional Perspectives,* New York, NY, John Wiley & Sons.

ANAS, A., ARNOTT, R. & SMALL, K. 1998. Urban spatial structure. *Journal of Economic Literature,* 36**,** 1426-1464.

ANDERSSON, E., MCPHEARSON, T., KREMER, P., GOMEZ-BAGGETHUN, E., HAASE, D., TUVENDAL, M. & WURSTER, D. 2015. Scale and context dependence of ecosysem service providing units. *Ecosystem Services***,** 157–164.

ANGELSTAM, P., GRODZYNSKYI, M., ANDERSSON, K., AXELSSON, R., ELBAKIDZE, M., KHOROSHEV, A. & NAUMOV, V. 2013. Measurement, Collaborative Learning and Research for Sustainable Use of Ecosystem Services: Landscape Concepts and Europe as Laboratory. *AMBIO: A Journal of the Human Environment,* 42**,** 129–145.

ANTHROP, M. 2004. Landscape change and the urbanisation process in Europe. *Landscape and Urban Planning,* 67**,** 9–26.

APPLETON, J. 1975. *The experience of landscape,* London, UK, Wiley.

ARCHER, B. & COOPER, C. 1994. The positive and negative impacts of tourism. *In:* W.F. THEOBALD (ED.), G. T., BUTTERWORTH-HEINEMANN, OXFORD (1994), PP. 73–9 (ed.) *Global tourism.* Oxford, UK: Butterworth-Heinemann.

ARMSTRONG, D. 2000. A survey of community gardens in upstate New York: implications for health promotion and community development. *Health & Place***,** 319-327.

ARNBERGER, A. 2006. Recreation use of urban forests: An inter-area comparison. *Urban Forestry & Urban Greening***,** 135-144.

ARNHEIM, R. 1974. *Entropy and art: An essay on disorder and order*, Univ of California Press.

ARNTZEN, S. & BRADY, E. 2008. *Introduction, Humans in the Land: The ethics and aesthetics and of the cultural landscape,* New York, NY, Unipub.

ASPINALL, P., MAVROS, P., COYNE, R. & ROE, J. 2013. The urban brain: Analysing outdoor physical activity with mobile EEG. *British Journal of Sports Medicine***,** 272–276.

ATTWELL, A. & A. BEER, J. B., K. BJORNBERG, M. BUIZER, J.M. CHAPA, C. COSTANZI, B. DUHEM, U. ELLEFSEN, E. ERHART, M. ERONEN, P. GRAHN, G. GRUNDT, S. GULDAGER, J.M. HALLEUX, P. HANOCQ, I. HANOUSKOVA, C. HARRISON, K. JORGENSEN, E. KALISZUK, T.KUCERA, K. LAPINTIE, G. LINDHOLM, O. MAIJALA, B. MALBERT, L. MARTINCIGH, M. MERIGGI, S. NYHUUS, B. OPPERMANN, S. PAULEIT, U. REEH, G. SCUDO, S. SCHO BEL, A. STA HLE, R. STILES, B. SZULCZEWSKA, S. TJALLINGII, I. VA HA - PIIKKIO , A. VAN HERZELE, M. VESELY, K. WAGNER, A.C. WERQUIN, K. ZALECKIS 2005. Green Structure and Urban Planning. Final report *In:* ANN CAROLL WERQUIN, B. D., GUNILLA LINDHOLM, BETTINA OPPERMANN, STEPHAN PAULEIT, SYBRAND TJALLINGII (ed.) *European Commission COST Action C11*. Brussels, Belgium: EU Publications Office (OPOCE).

AUGUSTINE, D. J. & FRELICH, L. E. 1998. Effects of white-tailed deer on populations of an understory forb in fragmented deciduous forests. *Conservation Biology,* 12**,** 995-1004.

AZERRAD, J. M. & NILON, C. H. 2006. An evaluation of agency conservation guidelines to better address planning efforts by local government. *Landscape and Urban Planning***,** 255–262.

BAGUETTE, M., BLANCHET, S., LEGRAND, D., STEVENS, V. M. & TURLURE, C. 2013. Individual dispersal, landscape connectivity and ecological networks. *Biological Reviews Of The Cambridge Philosophical Society,* 88**,** 310-326.

BALL, K., BAUMAN, A., LESLIE, E. & OWEN, N. 2001. *Perceived Environmental Aesthetics and Convenience and Company Are Associated with Walking for Exercise among Australian Adults*.

BARKER, R. G. 1968. *Ecological Psychology: Concepts and methods for studying the environment of human behavior,* Palo Alto, CA, Stanford University Press.

BARKMANN, J. & WINDHORST, W. 2000. Hedging our bets: the utility of ecological integrity

. *In:* JOERGENSEN, S. E. M., F. (ed.) *Handbook of Ecosystem Theories and Management.* Boca Raton, FL: Lewis Publishers.

BASTIAN, O. 2002. Landscape Ecology. *Landscape Ecology – towards a unified discipline?***,** 757–766.

BATTY, M., CHIN, N. & BESUSSI, E. 2003. SCATTER - Traffic, Urban Growth and Suburban Sprawl. *Mobilidade Para Todos.* Liston, Portugal.

BAWA-CAVIA, A. 2010. Sensing The Urban: Using location-based social network data in urban analysis. Center for Advanced Spatial Analysis: University College London.

BAYCAN-LEVENT, T., VREEKER, R. & NIJKAMP, P. 2009. A multi-criteria evaluation of green space in European cities. *European Urban and Regional Studies* 16**,** 193-213.

BEATON, D., BOMBARDIER, C., GUILLEMIN, F. & FERRAZ, M. 2000. Guidelines for the process of cross-cultural adaptation of self-report measure. *Spine,* 25**,** 3186-3191.

BECKER, E. 2012. *Social-ecological systems as epistemic objects*, London, UK, Routledge.

BECKER, E. & JAHN, T. 1999. *Sustainability and the Social Sciences: A Cross-Disciplinary Approach to Integrating Environmental Consideration into Theoretical Reorientation,* Paris, France, UNESCO.

BELL, S. 1993. *Elements of Visual Design in the Landscape,* London, UK, FN Spon.
BELL, S., HAMILTON, V., MONTARZINO, A., ROTHNIE, H., TRAVLOU, P. & ALVES, S. 2008. Greenspace and Quality of Life: A Critical Literature Review. *In:* SCOTLAND, G. (ed.) *Greenspace Scotland Research Report.* Stirling, Scotland.
BELL, S., MONTARZINO, A. & TRAVLOU, P. 2007. Mapping research priorities for green and public urban space in the UK. *Urban Forestry & Urban Greening***,** 103-115.
BELL, S., MORRIS, N., FINDLAY, C., TRAVLOU, P., MONTARZINO, A., GOOCH, D., GREGORY, G. & WARD THOMPSON, C. 2004. Nature for people: the importance of green spaces to East Midlands communities. *English Nature Research Reports.* Peterborough: English Nature.
BELL, S. & WARD THOMPSON, C. 2003. Contested views of freedom and control: children, teenagers and urban fringe woodlands in Central Scotland. *Urban Forestry & Urban Greening***,** 87-100.
BERKES, F. & FOLKE, C. 1998. *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience,* New York, NY, Cambridge University Press.
BERKES, F., FOLKE, C. & COLDING, J. 2003. *Navigating social–ecological systems: building resilience for complexity and change,* Cambridge, UK, Cambridge University Press.
BERKOWITZ, A. R., NILON, C. H. & HOLLWEG, K. S. 2003. *Understanding Urban Ecosystems: A New Frontier for Science and Education,* New York, NY, Springer-Verlag New York, Inc. .
BERTALANFFY, L. V. 1968 General System Theory - Foundations, Development, Applications. New York, NY: George Braziller.
BINDER, C. H., J.; BOTS, P; PAHL-WOSTL, C. 2013. Comparison of frameworks for analyzing social–ecological systems. *Ecology and Society,* 18**,** 18-26.
BOGAERT, J., FARINA, A. & CEULEMANS, R. 2005. Entropy increase of fragmented habitats: A sign of human impact? *Ecological Indicators***,** 207–212.
BOLUND, P. & HUNHAMMAR, S. 1999. Ecosystem services in urban areas. *Ecological Economics,* 29**,** 293–301.
BOTEQUILHA-LEITÃO, A. 2012. Eco-Polycentric Urban Systems: An Ecological Region Perspective for Network Cities. *Challenges,* 01/2012**,** 1-42.
BOURASSA, S. C. 1991. *The Aesthetics of Landscape,* BeUhaven Press.
BOWMAN, T., THOMPSON, J. & TYNDALL, J. 2012. Resident, developer, and city staff perceptions of LID and CSD subdivision design approaches. *Landscape and urban planning,* 107**,** 43-54.
BRENNAN, T. 1959. Reshaping a City, Glasgow. Glasgow, Scotland: University of Glasgow.
BRIGHENTI, A. 2013. *Urban Interstices: The Aesthetics and the Politics of the In-between,* Farnham, Burlington, Ashgate.
BRONFENBRENNER, U. 1979. *The ecology of human development : experiments by nature and design,* Cambridge, MA, Harvard University Press.
BROWN, L. 1993. The New Shorter Oxford English Dictionary: on Historical Principles. Oxford, UK: Clarendon.
BROWNSON, R. C., BAKER, E. A., HOUSEMANN, R. A., BRENNAN, L. K. & BACAK, S. J. 2001. Environmental and policy determinants of physical activity in the United States. *Am J Public Health,* 91.
BROYLES, S. M., A; THEALL, K.; GUSTAT, J. AND RUNG, A. 2011. Integrating Social Capital Into a Park-Use and Active-Living Framework. *American Journal of Preventive Medicine,* 40**,** 522–529.
BRUECKNER, J. & FANSLER, D. 1983. The Economics of Urban Spmwl: Theory and Evidence on the Spatial Sizes of Cities. *Review of Economics and Statisrics,* 65**,** 479-482.
BUECHNER, M. 1987. Conservation in insular parks: simulation models of factors affecting the movement of animals across park boundaries. *Biological Conservation,* 41**,** 57-76.

BURGER, M. & MEIJERS, E. 2012. Form follows function? Linking morphological and functional polycentricity. *Urban Studies,* 49**,** 127–1149.

BURGESS, J. 1998. But is it worth taking the risk?' How women negotiate access to urban woodland: a case study. *In:* AINLEY, R. (ed.) *New frontiers of space, bodies and gender*. London, UK: Routledte.

BURGESS, J., HARRISON, C. & LIMB, M. 1988. People, parks and the urban green: A study of popular meanings and values for open spaces in the city. *Urban Studies,* 25**,** 455-473.

BURKHARD, B., PETROSILLO, I. & COSTANZA, R. 2012. Ecosystem services , Bridging ecology, economy and social sciences. *Ecological Complexity,* 7**,** 257-259.

BURNLEY, L. H. & MURPHY, P. A. 1995. Exurban development in Australia and the United States: through a glass darkly. *Journal of Planning Education and Research,* 14**,** 245-254.

CAMFIELD, L., CRIVELLO, G. & WOODHEAD, M. 2009. Wellbeing research in developing countries: Reviewing the role of qualitative methods. *Social Indicators Research,* 90**,** 5-31.

CAMFIELD, L. & GUILLEN-ROYO, M. 2010. Wants, needs and satisfaction: A comparative study in Thailand and Bangladesh. *Social Indicators Research,* 96**,** 183-203.

CAMPO, D. 2013. *The Accidental Playground,* Oxford, UK, Fordham University Press.

CARNEGIE, M. A., BAUMAN, A., MARSHALL, A. L., MOHSIN, M., WESTLEY-WISE, V. & BOOTH, M. L. 2002. Perceptions of the Physical Environment, Stage of Change for Physical Activity, and Walking among Australian Adults. *Research Quarterly for Exercise and Sport,* 73**,** 146--155.

CARVALHO, F., DE MARCO, P. & FERREIRA, L. 2009. The Cerrado into-pieces: Habitat fragmentation as a function of landscape use in the savannas of central Brazil. *Biological Conservation,* 142**,** 1392-1403.

CASTELLS, M. 1996. *The Rise of the Network Society, The Information Age: Economy, Society and Culture,* Oxford, UK, Blackwell.

CENTRE, E.-E. E. A. A. J. R. 2006. Urban sprawl in Europe. Copenhagen, Denmark: EEA.

CERMASI, O. & PSARRA, S. Space syntax, landscape urbanism and the peri-urban condition: the case of Bologna and Modena in Italy. *In:* KIM, Y. O., PARK, H. T. AND SEO, K. W, ed. Proceedings of the Ninth International Space Syntax Symposium, 2013 Seoul, South Korea. Sejong University, 1-18.

CHAPIN, F. S., III , ZAVALETA, E. S., EVINER, V. T., NAYLOR, R. L., VITOUSEK, P. M., REYNOLDS, H. L., HOOPER, D. U., LAVOREL, S., SALA, O. E., HOBBIE, S. E., MACK, M. C. & DIAZ, S. 2000. Consequences of changing biodiversity. *Nature***,** 234–242.

CHEMERO, A. 2003. An outline of a theory of afifordances. *Ecological Psychology,* 15**,** 181-195.

CHEN, J., FRANKLIN, J. & SPIES, T. 1992. Vegetation responses to edge environments in old-growth Douglas-fir forests. *Ecological Applications,* 2**,** 387-396.

CHIESURA, A. 2004. The role of urban parks for the sustainable city. *Landscape and Urban Planning***,** 129-139.

CITY OF VANTAA, F. 2012. State of the Environment in Vantaa, Summary. Centre for Environmental Affairs.

CHRISTAKOPOULOU, S., DAWSON, JON AND AIKATERINI, GARI 2001. The Community Well-Being Questionnaire: Theoretical Context and Initial Assessment of Its Reliability and Validity. *Social Indicators Research,* 56**,** 328.

CHRISTOPH, B. & NOLL, H.-H. 2003. Subjective Well-Being in the European Union During the 90s. *Social Indicators Research,* 64**,** 197.

CLARK, C. & UZZELL, D. L. 2002. THE AFFORDANCES OF THE HOME, NEIGHBOURHOOD, SCHOOL AND TOWN CENTRE FOR ADOLESCENTS. *Journal of Environmental Psychology,* 22**,** 95--108.

COHEN, D. A., INAGAMI, S. & FINCH, B. 2008. The built environment and collective efficacy. *Health & Place* 198-208.
COLES, R. W. & BUSSEY, S. C. 2000. Urban forest landscapes in the UK – progressing the social agenda. *Landscape and Urban Planning,* 52**,** 181-188.
COLEY, R. L., KUO, F. E. & SULLIVAN, W. C. 1997. Where does community grow? The social context created by nature in urban public housing. *Environment and Behavior,* 29**,** 468-494.
COLLINGE, S. K. 2009. *Ecology of fragmented landscapes,* Baltimore, Maryland, The Johns Hopkins University Press.
COMMISSION, E.-E. 2010a. Investing in Europe's future, Fifth Report on Economic , Social and Territorial Cohesion. Luxembourg: Office for Official Publications of the European Communities.
COMMISSION, E.-E. 2010b. Europe 2020. A strategy for smart, sustainable and inclusive growth. Brussels: Communication from the Commission. COM (2010) 2020 final.
COMMISSION, E.-E. 2011. Territorial Agenda of the European Union 2020: Towards an Inclusive Smart and Sustainable Europe of Diverse Regions. Luxembourg, Luxembourg: European Commission (EC).
COMMITTEE, U. W. H. Operational Guidelines for the Implementation of the World Heritage Convention. UNESCO World Heritage Committee, 2012 UNESCO World Heritage Centre, Paris. 14.
CONSULTANTS, L. U. 2008. Greenspace Strategy. Glasgow, Scotland: East Renfrewshire Council and Scottish Natural Heritage.
COOPER MARCUS, C. 2005. Healing gardens in hospitals. *In:* WAGENAAR, C. (ed.) *The architecture of hospitals.* Rotterdam.: NAi Publishers.
COSGROVE, D. 1993. Landscapes and myths, gods and humans. *In:* BENDER, B. (ed.) *Landscape: Politics and perspectives.* Berg: Oxford.
COSTANZA, R., D'ARGE, R., DE GROOT, S., FARBER, M., GRASSO, B., HANNON, K., LIMBURG, S., NAEEM, R. V., O'NEILL, J., PARUELO, R. G., RASKIN, R., SUTTON, A. & BELT, M. V. D. 1997. The value of the world's ecosystem services and natural capita. *Nature***,** 253–260.
COUCH, C., LEONTIDOU, L. & PETSCHEL-HELD, G. 2007. *Urban Sprawl in Europe: Landscapes, Land-use Change and Policy* Oxford, UK, Blackwell.
CRESWELL, J. W. & PLANO CLARK, V. L. 2007. *Designing and conducting mixed-methods research,* Thousand Oaks, CA, SAGE.
CRESWELL, J. W., PLANO CLARK, V. L., GUTMANN, M. L. & HANSON, W. E. 2003. Advanced mixed methods research designs. *Handbook of mixed methods in social and behavioral research,* 209**,** 240.
CRUMP, J. R. 2003. Finding a Place in the County: Exurban and Suburban Development in Sonoma County, California. *Environment and Behavior,* 35**,** 187–202.
CRUTZEN, P. & STOERMER, E. 2000. The 'Anthropocene'. *In:* NEWSLETTER, I. (ed.).
CUMMING, S. 2014. Theoretical Frameworks for the Analysis of Social–Ecological Systems. *In:* SAKAI, S. A. U., C. (ed.) *Social-Ecological Systems in Transition.* New York, NY: Springer.
CUMMINS, R. A. 1997. Assessing Quality of Life. *In:* BROWN, R. (ed.) *Quality of Life for People with Disabilities. Models, Research and Practice.* 2 ed. Cheltenham, UK: Stanley Thornes (Publishers) Ltd.
D., I. & A.W., D. 2000. Defining the peri-urban: rural–urban linkages and institutional connections. *Land Reform.* Rome: UN Food and Agriculture Organization.
DAILY, G. 1997. *Nature's services: societal dependence on natural ecosystems,* Island Press.
DAMSGAARD, O., DOUCE, T. P., DRAHOS, Z., GERE, L., ILLÉS, I., JETMAR, M., KOMORNICKI, T., LOPEZ, I., PÉTI, M., PROKAI, R., RADVÁNSZKI, Á., RICZ, J., SALAMIN, G., SCHMIDT-SEIWERT, V., SCHÖN, P., SOMFAI, Á., SÜTŐ, A., TOMAY, K., VANAUTGAERDEN, L. & ZAUCHA, J. 2011. The Territorial State and Perspectives of the European Union. Background document for the Territorial

Agenda of the European Union 2020. Budapest, Hungary: Hungarian Ministry of National Development and VÁTI Nonprofit Ltd.
DANIELS, T. 2009. A trail across time: American environmental planning from City Beautiful to Sustainability. *Journal of the American Planning Association,* 75**,** 178-192.
DAVIS, J. S., NELSON, A. C. & DUEKER, K. J. 1994. The new burbs. The exburbs and their implications for planning policy. *Journal of the American Planning Association,* 60**,** 45-59.
DE GEYTER, X. 2002. *After-Sprawl: Research On The Contemporary City,* Rotterdam, The Netherlands, NAi Publishers.
DE GROOT, R. S. 1992. *Functions of nature: evaluation of nature in environmental planning, management and decision making,* Wolters-Noordhoff BV.
DE VRIES, S. 2010. Nearby nature and human health: Looking at mechanisms and their implications. *In:* C. WARD THOMPSON, P. A., & S. BELL (ed.) *Innovative approaches to researching landscape and health – Open space: People space 2.* Abingdon: Routledge.
DEL TREDICI, P. 2010. Spontaneous urban vegetation: reflections of change in a globalized world. *Nature and Culture,* 5**,** 299–315.
DEMPSEY, N. 2009. Are Good-Quality Environments Socially Cohesive? Measuring Quality and Cohesion in Urban Neighbourhoods. *Town Planning Review,* 80**,** 315-345.
DEPARTMENT FOR TRANSPORT, L. G. A. T. R.-D. 2002. Green Spaces, Better Places London, UK: Urban Green Spaces Taskforce
DEVELOPMENT, C. F. S. 1999. The European Spatial Development Perspective. Luxembourg: Commission of the European Communities.
DEVELOPMENT, O.-O. F. E. C.-O. A. 2002. Urban Renaissance — Glasgow: Lessons for Innovation and Implementation Paris, France.
DEVELOPMENT, O.-T. O. F. E. C.-O. A. 2013. Framework for Statistics on the Distribution of Household Income, Consumption and Wealth. Paris, France: OECD 2013.
DEVELOPMENT, S. D. F. U. 2009. Berlin Land Use Plan. Berlin, Germany.
DIAMOND, J. 1997. *Guns Germs and Steel: The Fate of Human Societies,* New York, NY, W.W. Norton & Co.
DIELEMAN, F. & FALUDI, A. 1998. Polynucleated metropolitan regions in Northwest Europe: theme of the special issue. *European Planning Studies,* 6**,** 365-377.
DIENER, E. 2009. Subjective Well-Being. *In:* DIENER, E. (ed.) *The Science of Well-Being* New York, NY: Springer.
DIENER, E., SCOLLON, C. & LUCAS, R. 2003. The evolving concept of subjective well-being. *Advances in Cell Aging and Gerontology,* 15**,** 187-219.
DIENER, E. & SUH, E. 1997. Measuring Quality of Life: Economic, Social, and Subjective Indicators. *Social Indicators Research,* 40**,** 189-216.
DINNIE, E., BROWN, K. M. & MORRIS, S. 2013. Community, cooperation and conflict: negotiating the social well-being benefits of urban greenspace experiences. *Landscape and Urban Planning,* 112**,** 1-9.
DRAMSTAD, W. E., SUNDII TVEIT, M., FJELLSTAD, W. J. & FRY, G. L. A. 2006. Relationships between visual landscape preferences and map-based indicators of landscape structure. *Landscape and Urban Planning,* 78**,** 465-474.
DURES, E. 2011. Mixed methods in health psychology: Theoretical and practical Considerations of the third paradigm. *Journal of Health Psychology,* 16**,** 332-341.
DUNCAN, M. & MUMMERY, K. 2005. Psychosocial and environmental factors associated with physical activity among city dwellers in regional Queensland. *Prev Med,* 40.
EUROSTAT 2006. Urban Audit Report 2006. *Urban Audit Reports.* Eurostat.
EEA, E. E. A.-. 2006. Urban Sprawl in Europe. The Ignored Challenge. *EEA Report Nr.10/2006.* Copenhagen, Denmark.
EEA, E. E. A.-. 2011. Landscape fragmentation in Europe. Copenhagen, Denmark.

ENGLAND, N. 2009. Experiencing Landscapes: Capturing the 'cultural services' and 'experiential qualities' of landscape. *Natural England Commissioned Report NECR024*. Cheltenham:, UK: Natural England.
ENGLAND, N. 2011. Green space access, green space use, physical activity and overweight. London, UK: Natural England.
ENTRIKIN, J. N. 1991. *The betweenness of place: Toward a geography of modernity*, Baltimore, MD, Johns Hopkins University Press.
ENVIRONMENT AGENCY, C. A., ENGLISH NATURE, RIVER NENE REGIONAL PARK AND ENGLISH HERITAGE 2005. Planning sustainable communities: A Green Infrastructure guide for Milton Keynes & the South Midlands. *England's Community Forests*. Nottingham:, UK: Environment Agency.
ERICSSON, K. A. 2002. Attaining excellence through deliberate practice: Insights from the study of expert performance. *In:* FERRARI, M. (ed.) *The pursuit of excellence through education*. ahwah, NJ: Lawrence Erlbaum Associates.
ESRI. 2012. *ArcGIS 10.1 Help* [Online]. Available: http://resources.arcgis.com/en/help/. [Accessed 2014].
EUROPE, C. O. 2007. Spatial development glossary. *CEMAT*. Strasbourg.
EUROSTAT 2006. Urban Audit Report 2006. *Urban Audit Reports*. Eurostat.
EWERS, R. & DIDHAM, R. 2006. Confounding factors in the detection of species responses to habitat fragmentation. *Biological Reviews*, 81**,** 117-142.
EWING, R. 1997. Is Los Angeles-style sprawl desirable? *Journal of the American Planning Association*, 63**,** 107–126.
EWING, R. 2008. Characteristics, Causes, and Effects of Sprawl: A Literature Review *Environmental and Urban issues*, 21**,** 1-15.
FAEHNLE, M., BA CKLUND, P. & TYRVA INEN, L. 2011. Looking for the role of nature experiences in planning and decision making: a perspective from the Helsinki Metropolitan Area. *Sustainability: Science, Practice, & Policy*, 7.
FAHRIG, L. 2003. Effects of habitat fragmentation on biodiversity. *Annual Review of Ecology, Evolution, and Systematics***,** 487–515.
FAO, U. A. 1999. Terminology for Integrated Resources Planning and Management. Rome, Italy and Nairobi, Kenia: Food and Agriculture Organization and United Nations Environmental Programme.
FARINA, A. 2000. The cultural landscape as a model for the integration of ecology and economics. *BioScience***,** 313-320.
FARINA, A. & BELGRANO, A. 2006. The eco-field hypothesis: toward a cognitive landscape. *Landscape Ecology*, 21**,** 5-17.
FIELD, D., PR, V., TK, K., RB, H. & VC., R. 2003. Reaffirming social landscape analysis in landscape ecology: A conceptual framework. *Society & Natural Resources***,** 349–361.
FISHER, B., TURNER, K. K. & MARLING, P. 2009. Defining and classifying ecosystem services for decision making. *Ecological Economics*, 68**,** 643-655.
FLETCHER JR., R. 2005. Multiple edge effects and their implications in fragmented landscapes. *Journal of Animal Ecology*, 74**,** 342-355.
FOTHERINGHAM, S. A., BRUNSDON, C. & CHARLTON, M. 2000. *Quantitative geography: perspectives on spatial data analysis*, Sage Publications.
FLORIDA, R., GULDEN, T. & MELLANDER, C. 2008. The Rise of the Mega Region. *Cambridge Journal of Regions, Economy and Society***,** 459-476.
FORMAN, R. T. T. 1995. Some general principles of landscape and regional ecology. *Landscape ecology*, 10**,** 133-142.
FORMAN, R. T. T., AND M. GODRON 1986. *Landscape ecology*, New York., NY, Wiley.
FOUNDATION, M. H. 2012. *Mental Health Toolbox* [Online]. Albany, NY: The Mental Health Foundation. Available: http://www.mentalhealthfoundation.net/mental-health-toolboxxx [Accessed March 2016 2016].
FRANCK, K. A. & STEVENS, Q. 2007. *Loose Space: Possibility and Diversity in Urban Life*, London, UK, Routledge.

FRANCOVICH, C. 2010. An interpretation of the continuous adaptation of the self/environment process. *The International Journal of Interdisciplinary Social Sciences,* 5.

FRANKLIN, J. F., SPIES, T. A., VAN PELT, R., CAREY, A. B., THORNBURGH, D. A., BERG, D. R., LINDENMAYER, D. B., HARMON, M. E., KEETON, W. S. & SHAW, D. C. 2002. Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example. *Forest Ecology and Management,* 155**,** 399-423.

FREEMAN, C. & BUCK, O. 2003. Development of an ecological mapping methodology for urban areas in New Zealand. *Landscape and Urban Planning,* 63**,** 161–173.

FREY, B. & STUTZER, A. 2002. *Happiness and economics,* Princeton, N.J, Princeton University Press.

FRIEDMANN , J. 1986. The world city hypothesis. *Development & Change,* 17**,** 69-83.

FRUMKIN, H. 2003. Healthy places: exploring the evidence. *American journal of public health,* 93**,** 1451-1456.

FULLER, R. A., IRVINE, K. N., DEVINE-WRIGHT, P., WARREN, P. H. & GASTON, K. J. 2007. Psychological benefits of greenspace increase with biodiversity. *Biological Letters***,** 390-394.

GALLENT, N. A., J. AND BIANCONI, M. 2006. *Planning on the edge: the context for planning at the rural–urban fringe,* Abingdon, UK, Routledge.

GALSTER, G. H., R.; AND RATCLIFFE, M. 2001. Wrestling sprawl to the ground: defining and measuring an elusive concept. *Housing Policy Debate,* 12**,** 681 – 717.

GARREAU, J. 1991. *Edge city: life on the new urban frontier,* New York, NY, Random House, Inc

GCVSDPA, G. A. T. C. V. S. P. J. C. 2009. *The Glasgow and the Clyde Valley Joint Structure Plan 2009* [Online]. Available: http://www.clydeplan-sdpa.gov.uk/index.php?option=com_content&view=article&id=20&Itemid=16 [Accessed 2014 Jun4\e 21].

GEDDES, P. 1915. *City in evolution,* London, UK, Williams and Norgate Ltd.

GEDDES, P. 1968. *Cities in evolution: an introduction to the town planning movement and to the study of civics,* London, UK, Benn.

GIBSON, J. J. 1977. The Theory of Affordances. *In:* BRANSFORD, R. S. A. J. (ed.) *Perceiving, Acting, and Knowing.* John Wiley & Sons Inc.

GIBSON, J. J. 1979. *The ecological approach to visual perception,* London, Lawrence Erlbaum Associates.

GILES-CORTI, B., BROOMHALL, M. H., KNUIMAN, M., COLLINS, C., DOUGLAS, K. & NG, K. 2005. Increasing walking – How important is distance to, attractiveness, and size of public open space? *American Journal of Preventive Medicine,* 28**,** 169-176.

GILPIN, M., HANSKI, E. & ILKKA, A. 1997. *Metapopulation biology: ecology, genetics, and evolution.*

GLOVER, T. D. & PARRY, D. C. 2005. Building relationships, accessing resources: mobilizing social capital in community garden contexts. *Journal of Leisure Research* 450-474.

GOBSTER, P. H. 1999. An ecological aesthetic for forest landscape managemen. *Landscape Journal,* 18**,** 54-64.

GOBSTER, P. H., NASSAUER, J. I., DANIEL, T. C. & FRY, G. 2007. The shared landscape: what does aesthetics have to do with ecology. *Landscape Ecology,* 22**,** 959-972.

GORDON, P., RICHARDSON, H. W. & WONG, H. L. 1986. The distribution of population employment in a polycentric city: the case of Los Angeles. *Environment and Planning A,* 18**,** 161-173.

GRAHN, P. & STIGSDOTTER, U. A. 2003. Landscape planning and stress. *Urban Forestry & Urban Greening***,** 1–18.

GRAZULEVICIUTE-VILENISKE, I., ZALESKIENE, E., GINTARE BALTRUSAITYTE & RUBIKAITE, A. 2015. Urbanization Influence on the Relicts of Soviet Rural Landscape. Case of Lithuania. *SAGE Open***,** 1-18.

GREENO, J. G. 1994. Gibson's Affordances. *Psychological Review,* 101**,** 336-342.

GRIGONIS, V. 2013. World cities and urban form: Fragmented, polycentric, sustainable? *Urban Design International,* 18**,** 182-183.

GROENEWEGEN, P., VAN DEN BERG, A., DE VRIES, S. & VERHEIJ, R. 2006. *Vitamin G: Effects of green space on health, well-being, and social safety*.

GCVSDPA, G. A. T. C. V. S. P. J. C. 2009. *The Glasgow and the Clyde Valley Joint Structure Plan 2009* [Online]. Available: http://www.clydeplan-sdpa.gov.uk/index.php?option=com_content&view=article&id=20&Itemid=16 [Accessed 2014 Jun4\e 21].

GUBA, E. G. & LINCOLN, Y. S. 2005. Paradigmatic controversies, contradictions, and emerging confluences. *In:* DENZIN, N. K. L., Y. S. (ed.) *The Sage Handbook of Qualitative Research* 3rd ed. Thousand Oaks, CA: Sage.

GUITART, D., PICKERING, C. & BYRNE, J. 2012. Past results and future directions in urban community gardens research. *Urban Forestry & Urban Greening***,** 364–373.

GULINCK, H., DUFOURMONT, H. & STAS, I. 1999. Approach to landscape character using satellite imagery and spatial analysis tools. *In:* USHER, M. B. (ed.) *Landscape Character: Perspectives on Management and Change.* Edinburgh, UK: The Stationery Office.

GUMPLOWICZ, L. 1963. *Outlines of sociology* New York, NY, Paine-Whitman.

GUNDERSON, L. H. 2000. Ecological resilience--in theory and application. *Annual review of ecology and systematics***,** 425-439.

HAASE, D. 2014. The nature of urban land use and why it is a special case. *In:* K. SETO, A. R., AND J. LUPP (ed.) *Rethinking global land use in an urban era.* Cambridge, MA: Strüngmann Forum Reports.

HAASE, G. 1991. Approaches and methods of landscape diagnosis. *Ekológia ČSFR,* 9**,** 31–44.

HABRAKEN, N. J. 1998. *The structure of the ordinary,* Cambridge, MA, MIT Press.

HAINES, V. A. 1986. Energy and Urban Form: A Human Ecological Critique. *Urban Affairs Review,* 21**,** 337-353.

HAINES-YOUNG, R. & POTSCHIN, M. 2010. The links between biodiversity, ecosystem services and human well-being. *In:* FRID, D. R. C. (ed.) *Ecosystem ecology: A new synthesis.* Cambridge, UK: BES: Cambridge University Press.

HALBERT, L. & PAIN, K. 2009. PAR-LON–doing business in knowledge-based services in Paris and London: a tale of one city? *GaWC Research Bulletin No. 307*.

HALL, P. 1998. *Sociable Cites: The Legacy of Ebenezer Howard,* Chichester, Wiley.

HALL, P. 1999. The future of cities. *Computers, environment and urban systems,* 23**,** 173-185.

HALL, P. 2009. The Polycentric Metropolis: A Western European Perspective on Megacity Regions [J]. *Journal of Urban and Regional Planning,* 3**,** 004.

HALL, P. G. & PAIN, K. 2006. *The polycentric metropolis: learning from mega-city regions in Europe,* New York, NY, Routledge.

HANDY, S., CAO, X. & MOKHTARIAN, P. 2006. Self-selection in the relationship between the built environment and walking: empirical evidence from Northern California. *Journal of the American Planning Association,* 72**,** 55-74.

HANNIKAINEN, M. 2013. Full Report of the 'Green Issues' Project : Classification of Green Spaces in Helsinki and Vantaa. Helsinki University of Helsinki.

HANSEN, R., FRANTZESKAKI, N., MCPHEARSON, T., RALL, E., KABISCH, N., KACZOROWSKA, A., KAIN, J., ARTMANN, M. & PAULEIT, S. 2015. The uptake of the ecosystem services concept in planning discourses of European and American cities. *Ecosystem Services,* 12**,** 228–246.

HANSEN R., F. N., MCPHEARSON T., RALL E., KABISCH N., KACZOROWSKA A., KAIN J.-H., ARTMANN M., PAULEIT S., 2015. THE UPTAKE OF THE ECOSYSTEM SERVICES CONCEPT IN PLANNING DISCOURSES OF EUROPEAN AND AMERICAN CITIES. ECOSYSTEM SERVICES, 12: 228–246.

HARDT, E., PEREIRA-SILVA EFL, DOS SANTOS RF, TAMASHIRO JY, RAGAZZI S, LINS D. 2013. The influence of natural and anthropogenic landscapes on edge effects. *Landscape and Urban Planning* 120**,** 59-69.

HARRIS, L. D. 1984. *The Fragmented Forest: Island Biogeography Theory and the Preservation of Biotic Diversity*, Chicago, IL., University of Chicago Press.

HARTIG, T., MANG, M. & EVANS, G. W. 1991. Restorative effects of natural environment experiences. *Environment and Behavior***,** 3-26.

HEFT, H. 2001. *Ecological Psychology in Context: James Gibson, Roger Barker, and the Legacy of William James's Radical Empiricism*, Mahwah, NJ, Lawrence Erlbaum Associates.

HEFT, H. 2003. Affordances, dynamic experience, and the challenge of reification. *Ecological Psychology,* 15**,** 149-180.

HEIKKINEN, I. 2007. Saving nature for people: National strategy and action plan for conservation and sustainable use of biodiversity in Finland 2006–2016. Helsinki, Finland: The Finnish Environment Institute.

HELLMUND, P. & SMITH, D. 2006. *Designing Greenways: Sustainable Landscapes for Nature and People*, Washington, DC, Island Press.

HELMINEN, V. & M., R. 2008. Kyla¨asutuksen kehitys kaupunkiseuduilla ja maaseudulla (Village settlement in Finnish peri-urban and rural areas). *Urban sprawl in Europe—an ignored challenge.* . Copenhagen, Denmark: EEA.

HERITAGE, C. A. A. S. N. 2002. Landscape character assessment: guidance for England and Scotland. Cheltenham, UK: Countryside Agency.

HERRSCHEL, T. 2010. Cities, suburbs and metropolitan areas – governing the regionalised city. *Urban Sociology,* 10**,** 107-130.

HERZOG, T. R. & CHERNICK, K. K. 2000. Tranquillity and danger in urban and natural settings. *Journal of Environmental Psychology***,** 29-39.

HESSBURG, P. F., SMITH, B. G. & SALTER, R. B. 1999. Detecting Change in Forest Sptaial patterns from Reference Conditions *Ecological Applications,* 9**,** 1232-1252.

HICKMANN, S. A., LEE, R. E., SALLIS, J. F., CASTRO, C. M. & CHEN, A. H. 1999. The Association of Physical Activity Change with Self-Esteem in Ethnic Minority Women: A Prospective Analysis. *Journal of Gender, Culture and Health,* 4**,** 281-292.

HIETALA, R., TYRVÄINEN, L., SILVENNOINEN, H. & TÓTH, B. 2012. Patterns of change in land use and its relation to green spaces in an urban fringe case study Vantaa City, Southern Finland. *Landscape Research,* 38**,** 576-592.

HILTUNEN, M. J. 1998. Ecological Aspects in Suburban Renewal and Experiences in Finland. *In:* J. BREUSTE, H. F., O. UHLMAN (ed.) *Urban Ecology.* New York, NY: Springer.

HIRD, S. 2003. What is well-being? A brief review of current literature and concepts. NHS Scotland.

HOEHNER, C., RAMIREZ, L., ELLIOTT, M., HANDY, S. & BROWNSON, R. 2005. Perceived and objective environmental measures and physical activity among urban adults. *American Journal of Preventive Medicine,* 28**,** 105-111.

HOLLING, C. S. 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics,* 4**,** 1-23.

HOUSTON, P. 2005. Re valuing the Fringe: Some Findings on the Value of Agricultural Production in Australia's Peri Urban Regions. *Geographical Research,* 43**,** 209-223.

HUMPEL, N., OWEN, N., IVERSON, D., LESLIE, E. & BAUMAN, A. 2004. Perceived environment attributes, residential location, and walking for particular purposes. *Am J Prev Med,* 26.

I., T. & MEYER, W. B. 1994. *Global land-use and land-cover change: an overview*, Cambridge, London, UK, Cambridge University Press.

IAMATRAKUL, P., TEKNOMO, K. & GEJ HOKAO, K. 2005. Interaction of activity involvement and recreational location selection behavior in Lowland city: a case study of public parks in Saga city. *Journal of Zhejiang University,* 6A**,** 900-906.

IRWIN, S. 2006. *Combining data, enhancing explanation. NCRM Working Paper Series* [Online]. Available: http://www.ncrm.ac.uk/research/outputs/publications/WorkingPapers/2006/0306_combining_data.pd [Accessed 4/11/15].

ITTELSON, W. H. & CANTRIL, H. 1954. *Perception: A Transactional Approach*, New York, NY, Doubleday and Company.

J.R.A., M. & GM., F. Affordance-based methods for design. ASME International Conference on Design Theory and Methodology, 2003 Chicago, IL. The American Society of Mechanical Engineers.

JAAKKOLA, M. 2012. Helsinki, Finland: Greenness and Urban Form. *In:* BEATLEY, T. (ed.) *Green Cities of Europe.* Washington, D. C.: Island Press.

JACOBS, J. 1961. *The death and life of great American cities,* New York, NY, Random House.

JENKS, M. & KOZAK, D. 2008. Polycentrism and 'Defragmentation'. *World cities and urban form: fragmented, polycentric, sustainable?***,** 71.

JENKS, M., KOZAK, D. & TAKKANON, P. 2013. *World cities and urban form: fragmented, polycentric, sustainable?*, Routledge.

JONES, K. S. 2003. What is an affordance? *Ecological Psychology,* 15**,** 107.

JONGMAN, R. H. G. 2002. Landscape Planning for Biological Diversity in Europe. *Landscape Research,* 27**,** 187-195.

JORGENSEN, A. & KEENAN, R. 2012. *Urban Wildscapes,* New York, NY, Routledge.

K, T., K, H., B, K., S, S. & S., P. 2012. Does research applying the DPSIR framework support decision making. *Land Use Policy* 29**,** 102-110.

KABISCH, N. A. D. H. 2012. Green spaces of European cities revisited for 1990-2006. *Landscape and Urban Planning***,** 113–122.

KAHN, R. L. & JUSTER, F. T. 2002. Well-Being: Concepts and Measures. *Journal of Social Issues,* 58**,** 627-644.

KAPLAN, R. 1995. The Restorative Benefits of Nature: Toward an Integrative Framework. *Journal of Environmental Psychology,* 15**,** 169-182.

KAPLAN, R. 2001. The Nature of the View From Home: Psychological Benefits. *Environment and Behavior,* 33**,** 507-542.

KAPLAN, R. K., S. 1989. *The Experience of Nature: A Psychological Perspective,* New York, NY, Cambridge University Press.

KARJALAINEN, T. P. & OTTO HABECK, J. 2004. When 'The Environment' Comes to Visit: Local Environmental Knowledge in the Far North of Russia. *Environmental Values,* 13**,** 167-186.

KARR, J. R., 1992. Ecological integrity: protecting earth's life support systems. In: R. Costanza, B. Norton and B. Haskell, eds. *Ecosystem health: new goals for environmental management.* Washington, DC: Island Press, 223–238.

KARR, J. R., PIMENTEL, D., WESTRA, L. & NOSS, R. 2000. Health, integrity, and biological assessment: The importance of measuring whole things. *Ecological integrity: integrating environment, conservation, and health***,** 209-26.

KASANKO, O., M., BARREDO, J. I., LAVALLE, C., MCCORMICK, N., DEMICHELI, L., SAGRIS, V. & BREZGER, A. 2006. Are European cities becoming dispersed? A comparative analysis of 15 European urban areas. *Landscape and Urban Planning***,** 111–130.

KAZMIERCZAK, A. & CARTER, J. 2010. Adaptation to Climate Change Using Green and Blue Infrastructure. A Database of Case Studies. Manchester,UK: The University of Manchester.

KEITH, K. D. 1996. Measuring Quality of Life Across Cultures: Issues and Challenge. *In:* SCHALOCK, R. L. (ed.) *Quality of Life.* Washington, DC: American Association on Mental Retardation.

KELLERT, S. R. 1996. *The Value of Life: Biological Diversity and Human Society.*, Washington, DC, Shearwater Books.

KIM, J. & KAPLAN, R. 2004. Physical and psychological factors in sense of community: New urbanist Kentlands and nearby Orchard Village. *Environment and Behavior,* 36**,** 313-340.

KING, M. F., RENÓ, V. F. & NOVO, E. M. L. M. 2014. The Concept, Dimensions and Methods of Assessment of Human Well-Being within a Socioecological Context: A Literature Review. *Social Indicators Research,* 116**,** 681-698.

KISSLING, M., HEGETSCHWEILER, K. T., RUSTERHOLZ, H. P. & BAUR, B. 2009. Short-term and long-term effects of human trampling on above-ground vegetation, soil density, soil organic matter and soil microbial processes in suburban beech forests. *Applied Soil Ecology,* 42**,** 303-314.

KLOOSTERMAN, R. C. & LAMBREGTS, B. 2001. Clustering of economic activities in polycentric urban regions: the case of the Randstad. *Urban Studies,* 38**,** 717-732.

KLOOSTERMAN, R. C. A. M., S. 2001. The polycentric urban region: towards a research agenda. *Urban Studies,* 38**,** 623-634.

KOOMEN, E., DEKKERS, J. & DIJK, T. V. 2008. Open-space preservation in theNetherlands: Planning, practice and prospects. *Land Use Policy,* 25**,** 361-377.

KORPELA, K., KYTTA, M. & HARTIG, T. 2002. Restorative experience, self-regulation, and children's place preferences. *Journal of Environmental Psychology***,** 387–398.

KORPELA, K. M., HARTIG, T. & KAISER, F. G. 2001. Restorative Experience and Self-Regulation in Favorite Places. *Environment and Behavior,* 33**,** 572-589.

KORPELA, K. M., YL´EN, M., TYRVAINEN, L. & SILVENNOINEN, H. 2008. Determinants of restorative experiences in everyday favorite places. *Health & Place***,** 636-652.

KOSKELA, H. & PAIN, R. 2000. Revisiting Fear and Place: Women's Fear to Attack and the Built Environment. *Geoforum,* 31**,** 269-280.

KOTLIAR, N. B. & WIENS, J. A. 1990. Multiple scales of patchiness and patch structure: a hierarchical framework for the study of heterogeneity. *Oikos***,** 253-260.

KRENICHYN, K. 2006. 'The only place to go and be in the city': women talk about exercise, being outdoors, and the meanings of a large urban park. *Health & place,* 12**,** 631-643.

KUO, F. E., BACAIOCA, M. & SULLIVAN, W. C. 1998a. Transforming inner-city landscapes. Trees, sense of safety and preference. *Environment and Behavior,* 30**,** 28-59.

KUO, F. E., SULLIVAN, W. C., COLEY, R. L. & BRUNSON, L. 1998b. Fertile ground for community: Inner-city neighborhood common spaces. *American Journal of Community Psychology***,** 6.

KWEON, B. S., SULLIVAN, W. C. & WILEY, A. R. 1998. Green common spaces and the social interaction of inner-city older adults. *Environment and Behavior,* 30**,** 832-858.

KYTTÄ, M. 2002. Affordances of Children's Environments in the Context of Cities, Small Towns, Suburbs and Rural Villages in Finland and Belarus. *Journal of Environmental Psychology,* 22**,** 109-123.

KYTTÄ, M. 2004. The extent of children's independent mobility and the number of actualized affordances as criteria for child-friendly environments. *Journal of Environmental Psychology,* 24**,** 179-198.

KYTTÄ, M., BROBERG, A., TZOULAS, T. & SNABB, K. 2013. Towards contextually sensitive urban densification: Location-based softGIS knowledge revealing perceived residential environmental quality. *Landscape and Urban Planning***,** 30-46.

KYTTÄ, M. & KAHILA, M. 2009. SoftGIS Method as a Bridge Builder in Collaborative Urban Planning. *In:* GEERTMAN, S. S., J. (ed.) *Planning Support Systems: Best Practices and New Methods.* Springer.

LAMBERT, A. 2011. *The (mis)measurement of periurbanization* [Online]. Available: http://www.metropolitiques.eu/The-mis-measurement-of.html [Accessed 2015].
LAMBIN, E. 2001. The causes of land-use and land-cover change: moving beyond the myths. Global Environmental Change**,** 261–269.
LAMBREGTS, B. 2009. *The polycentric metropolis unpacked. Concepts, trends and policy in the Randstad Holland.* PhD, University of Amsterdam.
LASZLO, A. & KRIPPNER, S. 1998. Systems Theories: Their Origins, Foundations, and Development *In:* JORDAN, J. (ed.) *Systems Theories and A Priori Aspects of Perception.* Amsterdam, The Netherlands: Elsevier.
LATHAM, J., SHERRY, J. & ROTHWELL, J. 2013. Ecological Connectivity and Biodiversity Prioritisation in the Terrestrial Environment of Wales. *Staff Science Report No. 13/3/3.* Bangor, Wales: Countryside Council for Wales, CCW
LATHER, P. A. 1992. Postmodernism and the human sciences. *In:* KVALE, S. (ed.) *Psychology and Postmodernism.* London, UK: Sage.
LECHNER, F. 1991. Simmel on Social Space. *Theory, Culture & Society,* 8**,** 195-201.
LEE, A. C. K., JORDAN, H. C. & HORSLEY, J. 2015. Value of urban green spaces in promoting healthy living and wellbeing: prospects for planning. *Risk Management and Healthcare Policy,* 8**,** 131-137.
LEONTIDOU, L. & COUCH, C. 2007. Urban sprawl and hybrid city-scapes in Europe: comparisons, theory construction and conclusions. *In:* COUCH, C., LEONTIDOU, L. AND PETSCHEL-HELD, G. (ed.) *Urban sprawl in Europe: landscapes, land-use change and policy.* oxford, UK: Blackwell.
LÉVESQUE, L. 2002. Interstitial Landscape as Resources - A Few Thoughts About A Tactical. Approach to Urban Intervention. *Resource architecture - Main congress report and outlook.* Berlin, Germany: Birkhauser.
LI, H. & REYNOLDS, J. F. 1993. A new contagion index to quantify spatial patterns of landscapes. *Landscape Ecology,* 8**,** 155-162.
LIN, B. B. & FULLER, R. A. 2013. Sharing or sparing? How should we grow the world's cities? . *Journal of Applied Ecology,* 50**,** 1161-1168.
LINDHEIM, R. & SYME, S. 1993. Environments, people and health. *Annual Review of Public Health,* 4**,** 335-339.
LIU, J., DIETZ, T., CARPENTER, S. R., FOLKE, C., ALBERTI, M., REDMAN, C. L., SCHNEIDER, S. H. & OSTROM, E. 2009. Coupled human and natural systems. *AMBIO: A Journal of the Human Environment,* 36**,** 639-649.
LIU, J. & TAYLOR, W. W. 2002. Landscape integrity and integrated management *In:* LIU, J., AND TAYLOR, W.W. (ed.) *Integrating Landscape Ecology into Natural Resource Management.* Cambridge, United Kingdom: Cambridge University Press.
LIU, S., COSTANZA, R., FARBER, S. & TROY, A. 2010. Valuing ecosystem services: Theory, practice, and the need for a transdisciplinary synthesis. *Ecological Economics,* 1185**,** 54–78.
LITTLE, B. R. 1983. Personal projects: A rationale and method for investigation. *Environment and Behavior,* 15**,** 273-309.
LOIBL, W. & BELL, S. 2011. Population and migration. *In:* PIORR, A., RAVETZ, J. AND TOSICS, I. (ed.) *Peri-urbanisation in Europe.* Copenhagen, Denmark: Academic Books Life Sciences.
LOVEJOY, T. E., BIERREGAARD, R. O., RYLANDS, A., MALCOL, J., QUINTELA, C., HARPER, L., BROWN, K., POWELL, A., POWELL, G., SCHUBART, H. & HAYS, M. 1986. Edge and other effects of isolation on Amazon forest fragments. *In:* SOULÉ , M. E. (ed.) *Conservation Biology: The Science of Scarcity and Diversity.* Sunderland, MA: Sinauer.
LOVELL, S. T. & JOHNSTON, D. M. 2009. Designing landscapes for performance based on emerging principles in landscape ecology. *Ecology and Society,* 14**,** 44.
LUTZENHISER, L. 1994. Sociology, energy and interdisciplinary environmental science. *The American Sociologist***,** 58-79.

MAANTAY, J. A. 2013. Collapse of Place: Derelict Land, Deprivation, and Health Inequality in Glasgow, Scotland. *Cities and the Environment (CATE),* Article 10.
MAAS, J., VAN DILLEN, S. M. E., VERHEIJ, R. A. & GROENEWEGEN, P. P. 2009. Social contacts as a possible mechanism behind the relation between green space and health. *Health & Place,* 15**,** 586-595.
MAAT, K. & DE VRIES, P. Influence of Green Space Amenities in the Residential Environment on Travel Behaviour. *In:* TOWNES, M., ed. TRB 2003 Annual Meeting, 2003 Washington, DC. Transportation Research Board.
MACARTHUR, R. H. & WILSON, E. O. 1967. *The Theory of Island Biogeography,* Princeton, New Jersey, Princeton University Press,.
MACNAGHTEN, P. & URRY, J. 1998. *Contested Natures,* London, UK, SAGE Publications.
MASLOW, A. 1968. *Toward a psychology of being,* New York, NY, van Nostrand.
MATOS, R. 2009. Urban Landscape: Interstitial Spaces. *Landsape Review,* 13**,** 61-71.
MATSUOKA, R. & KAPLAN, R. 2008. People needs in the urban landscape: Analysis of Landscape and Urban Planning contributions. *Landscape and Urban Planning,* 84**,** 7-19.
MATSUOKA, R. H. 2010. Student performance and high school landscapes: Examining the links. *Landscape and Urban Planning,* 273-282.
MAZLINA, M., SAID, I. & MOHAMAD, I. 2012. Experiential contacts with green infrastructure's diversity and well-being of urban community. *Procedia - Social and Behavioral Sciences,* 49**,** 257–267.
MAZZA, L., BENNETT, G., NOCKER, D. & VAN DIGGELEN, R. 2011. Green infrastructure implementation and efficiency.
MCAULEY, E., BLISSMER, B., KATULA, J., DUNCAN, T. E. & MIHALKO, S. L. 2000. Physical activity, self-esteem, and self-efficacy relationships in older adults: A randomized controlled trial. *Annals of Behavioral Medicine,* 22**,** 131.
MCCORMACK, G. R., GILES-CORTI, B., BULSARA, M. & PIKORA, T. J. 2006. Correlates of distances traveled to use recreational facilities for physical activity behaviors. *International Journal of Behavioral Nutrition and Physical Activity,* 3**,** 18.
MCDONNELL, M. J. & PICKETT, S. T. 1990. Ecosystem structure and function along urban–rural gradients: an unexploited opportunity for ecology. *Ecology,* 71**,** 1232-1237.
MCDONNELL, M. J., PICKETT, S. T. A., GROFFMAN, P., BOHLEN, P., POUYAT, R. V., ZIPPERER, W. C., PARMELEE, R. W., CARREIRO, M. M. & MEDLEY, K. 1997. Ecosystem processes along an urban-to-rural gradient. *Urban Ecosystems,* 1**,** 21-36.
MCGARIGAL, K. & CUSHMAN, S. A. 2002. Comparative evaluation of experimental approaches to the study of habitat fragmentation effects. *Ecological Applications,* 12**,** 335-345.
MCGILLIVRAY, M. & CLARKE, M. 2006. Understanding human wellbeing. Tokyo, Japan: United Nations University.
MCGREGOR, J. A. 2004. Researching well-being: Communicating between the needs of policy makers and the needs of people. *Global Social Policy,* 4**,** 337-358.
MCKENDRY, D. 2008. Auckenback Health and Open Space Project. Glasgow, Scotland: Glasgow Centre for Population Health.
MEA, M. E. A.-. 2005. *Ecosystems and Human Well-being: Synthesis.,* Washington D.C, Island Press.
MEEBERG, G. A. 1993. Quality of life: A concept analysis. *Journal of Advanced Nursing,* 18**,** 32-38.
MEEUS, S. & GULINCK, H. 2008. Semi-Urban Areas in Landscape Research: A Review. *Living Reviews in Landscape Research,* 2**,** 3.
MEIJERS, E. & ROMEIN, A. 2003. Realizing potential: building regional organizing capacity in polycentric urban regions. *European Urban and Regional Studies,* 173–186.

MENATTI, L. & CASA DA ROCHA, A. 2016. Landscape and Health: Connecting Psychology, Aesthetics, and Philosophy through the Concept of Affordance. *Frontiers in Psychology,* 7.
MERTES, J. & HALL, J. 1996. Parks, Recreation, Open Space and Greenway Guidelines. Ashburn, VA: National Recreation and Park Association.
MICHALOS, A. C. 1980. Satisfaction and happiness. *Social Indicators Research,* 385-422.
MILES, I., SULLIVAN, W. C. & KUO, F. E. 1998. Ecological restoration volunteers: The benefits of participation. *Urban Ecosystems,* 2**,** 27-41.
MILLER, J. 2005. Biodiversity conservation and the extinction of experience. *Trends in Ecology & Evolution,* 20**,** 430-434.
MILLS, E. S. 1972. *Studies in the Structure of the Urban Economy.*, Baltimore, MD, Johns Hopkins Press.
MITCHELL, R., ASTELL-BURT, T. & RICHARDSON, E. 2011. A comparison of green space indicators for epidemiological research. *Journal of Epidemiology & Community Health,* 65**,** 853–858.
MITCHELL, R. & POPHAM, F. 2008. Effect of exposure to natural environment on health inequalities: An observational population study. *The Lancet,* 1655–1660.
MIYAWAKI, A. & GOLLEY, F. B. 1993. Forest reconstruction as ecological engineering. *Ecological engineering,* 2**,** 333-345.
MOORE, R. L., SCOTT, D. & GRAEFE, A. R. 1998. The effects of activity differences on recreation experiences along a suburban greenway trail. *Journal of Parks and Recreation Administration,* 16**,** 35-53.
MORRIS, N. 2003. Black and Minority Ethnic Groups and Public Open Space: Literature review. Edinburgh, UK: OPENspace.
MÖRTBERG, U. & BALFORS, B. 2007. Biodiversity in urban areas and applications in strategic planning. *In:* WLODARCZYK, D. (ed.) *Green Structures in the Sustainable City*. Brussels, Belgium: The Baltic University Press.
MUELLER, M.P., 2009. Educational reflections on the "ecological crisis": EcoJustice, environmentalism and sustainability. *Science and Education,* 18 (8), 1031–1056.
NAEEM, S. 2002. Ecosystem consequences of biodiversity loss: the evolution of a paradigm. *Ecology* 1537–1552.
NASCIMENTO, H., ANDRADE, A., CAMARGO, J., LAURANCE, W. F., LAURANCE, S. G. & RIBEIRO, J. 2006. Effects of the surrounding matrix on tree recruitment in Amazonian forest fragments. *Conservation Biology,* 20**,** 853–860.
NASSAUER, J. I. 1992. The appearance of ecological systems as a matter of policy. *Landscape Ecology,* 6**,** 239-250.
NASSAUER, J. I. 1995. Culture and changing landscape structure. *Landscape Ecology,* 19**,** 229-137.
NASSAUER, J. I. & CORRY, R. C. 2004. Using normative scenarios in landscape ecology. *Landscape Ecology,* 343-356.
NEIMANIS, A., CASTLEDEN, H. and RAINHAM, D., 2012. Examining the place of ecological integrity in environmental justice: A systematic review. *Local Environment,* 17 (3), 349–367.
NEUVONEN, M., SIEVÄNEN, T., TÖNNES, S. & KOSKELA, T. 2007. Access to green areas and the frequency of visits – A case study in Helsinki. 6**,** 235-247.
NIEMEIJER, D. & DE GROOT, R. 2008. A conceptual framework for selecting environmental indicator sets. *Ecological Indicators,* 8**,** 14-25.
NILSSON, K. S. B., PAULEIT, S., BELL, S., AALBERS, C. & NIELSEN, T. A. S. 2013. *Peri-urban futures: Scenarios and models for land use change in Europe,* New York, New York, Springer.
NORMAN, D. A. 2002. *The Design of Everyday Things,* New York, NY, Basic Books.
NUSSBAUM, M. C. 1992. Human Functioning and Social Justice: In Defense of Aristotelian Essentialism. *Political Theory,* 20**,** 202-246.

OWEN, N., HUMPEL, N., SALMON, J. & OJA, P. 2004. Environmental Influences on Physical Activity. *In:* OJA, P. & BORMS, J. (eds.) *Health Enhancing Physical Activity*. Berlin: International Society of Sport Science and Physical Education.

OXFORD -UNIVERSITY'S MIGRATION OBSERVATORY. 2011. *Scottish Biodiversity Strategy* [Online]. : . Available: http://www.migrationobservatory.ox.ac.uk; [Accessed May 23 2016].

PALLAGST, K., MARTINEZ-FERNANDEZ, C. & WIECHMANN, T. 2013. *Shrinking Cities - International Perspectives and Policy Implications*, New York, NY, Routledge Publishers

PARDINI, R., BUENO, A. D. A., GARDNER, T. A., PRADO, P. I. & METZGER, J. P. 2010. Beyond the fragmentation threshold hypothesis: regime shifts in biodiversity across fragmented landscapes. *Plos One*, 5**,** e13666.

PARK, B. J., FURUYA, K., KASETANI, T., TAKAYAMA, N., KAGAWA, T. & MIYAZAKI, Y. 2011. Relationship between psychological responses and physical environments in forest settings. *Landscape and Urban Planning***,** 24-32.

PARR, H. 2007. Mental health, nature work, and social inclusion. *Environment and Planning D: Society and Space*, 25**,** 537–561.

PARR, J. B. 2008. Cities and regions: problems and potentials. *Environment and Planning A* 40**,** 3009-326.

PARRISH, J. D., BRAUN, D. P. & UNNASCH, R. S. 2003. Are we conserving what we say we are? Measuring ecological integrity within protected areas. *BioScience*, 53**,** 851-860.

PAULEIT, S. & DUHME, F. 2000. Assessing the environmental performance of land cover types for urban planning. *Landscape and Urban Planning***,** 1-20.

PAULEIT, S., ENNOS, R. & GOLDING, Y. 2005. Modeling the environmental impacts of urban land use and land cover change—a study in Merseyside, UK. *Landscape and Urban Planning*, 71**,** 295-310.

PAYNE, L. L., MOWEN, A. J. & ORSEGA-SMITH, E. 2002. An Examination of Park Preferences and Behaviors Among Urban Residents: The Role of Residential Location, Race, and Age. *Leisure Sciences*, 24**,** 181-198.

PEISER, R. B. 1984. Does it pay to plan suburban growth? *Journal of the American Planning Association*, 50**,** 419-433.

PEREIRA, M. P. & DAILY, G. C. 2006. Modeling biodiversity dynamics in countryside landscapes. *Ecology*, 87**,** 1877-1885.

PERSPECTIVE, E.-E. S. D. 1999. Towards Balanced and Sustainable Development of the Territory of the European Union. Luxembourg: Office for the Official Publications of the European Communities.

PESCHARDT, K. K., SCHIPPERIJN, J. & STIGSDOTTER, U. K. 2012. Use of small public urban green spaces (SPUGS). *Urban Forestry & Urban Greening*, 11**,** 235-244.

PETERS, K., ELANDS, B. & BUIJS, A. 2010. Social interactions in urban parks: Stimulating social cohesion? *Urban Forestry \& Urban Greening*, 9**,** 93--100.

PICKETT, S. T. A., CADENASSO, M. L., GROVE, J. M., NILON, C. H., POUYAT, R. V., ZIPPERER, W. C. & CONSTANZA, R. 2001. Urban ecological systems: linking terrestrial ecological, physical, and socioeconomic components of metropolitan areas. *Annual Review of Ecology and Systematics***,** 122-157.

PLUREL 2013. In Peri- urbanisation in Europe. Towards European Policies to Sustain Urban–Rural Futures. *In:* PIORR A, R. J., TOSICS I (ed.). Copenhagen, Denmark: Forest & Landscape University of Copenhagen.

POLLARD, E. L. & LEE, P. D. 2003. Child Well-Being: a Systematic Review of the Literature. *Social Indicators Research*, 61**,** 59-78.

PRETTY, J., PEACOCK, J., HINE, R., SELLENS, M., SOUTH, N. & GRIFFIN, M. 2007. Green Exercise in the UK Countryside: Effects on Health and Psychological Well-Being, and Implications for Policy and Planning. *Journal of Environmental Planning and Management***,** 211-231.

PRETTY, J. N., PEACOCK, J., SELLENS, M. & GRIFFIN, M. 2005. The mental and physical health outcomes of green exercise. *International Journal of Environmental Health Research,* 319-337.

PRIEGO, C., BREUSTE, J. H. & ROJAS, J. 2008. Perception and Value of Nature in Urban Landscapes: a Com- parative Analysis of Cities in Germany, Chile and Spain. *Landscape Online,* 7**,** 1-22.

PURCELL, A. T. & LAMB, R. J. 1998. Preference and naturalness: An ecological approach. *Landscape and urban planning,* 42**,** 57-66.

PYLE, R. M. 2002. Eden in a vacant lot: special places, species, and kids in the neighborhood of life. *In:* KAHN, P. H., KELLERT, S.R. (ed.) *Children and nature: psychological, sociocultural, and ecolutionary investigations.* Cambridge, MA: MIT Press.

R.T.T., F. 1995. *Land Mosaics: The ecology of landscapes and regions.,* Cambridge, UK, Cambridge University Press.

RANNEY, J., BRUNER, M. & LEVENSON, J. 1981. The importance of edge in the structure and dynamics of forest islands. *In:* R. BURGESS, D. S. (ed.) *Forest Island Dynamics in Man-dominated Landscapes.* New York, NY: Springer-Verlag.

RANTA, P. 2012. *Urban Ecosystems - Response to Disturbances, Resilience and Ecological Memory.* PhD, University of Helsinki.

RAPPE, E. & KIVELA, S. 2005. Effects of garden visits on long-term care residents as related to depression. *Horticultural Technology,* 15**,** 298-303.

RAPPORT, D. J., CONSTANZA, R. & MCMICHAEL, A. J. 1998. Assessing ecosystem health. *Trends in Ecology and Evolution,* 13**,** 397-402.

RASIDIA, M., JAMIRSAHB, N. & SAID, I. 2012. Urban Green Space Design Affects Urban Residents' Social Interaction. *Procedia - Social and Behavioral Sciences,* 68**,** 464 – 480.

RAYMORE, L. A. 2002. Facilitators to leisure. *Journal of Leisure Research,* 34**,** 37-51.

REED, E. S. 1993. The intention to use a specific affordance: A conceptual framework for psychology. *In:* R.H WOZNIAK, K. W. F. (ed.) *Development in context. Acting and thinking in specific environments.* Hillsdale, NJ Lawrence Erlbaum Associates.

REED, E. S. 1996. *Encountering the world: Toward an ecological psychology,* Oxford, UK, Oxford University Press.

REKISTERITILANNE, V. 2015. Population - Register Center of Finland.

RG, G. & RJ., S. 1997. *Spatial behavior: A geographical perspective,* New York, NY, Guilford.

RIES, L., FLETCHER JR., R. J., BATTIN, J. & SISK, T. D. 2004. Ecological responses to habitat edges: mechanisms, models, and variability explained. *Annual Review of Ecology and Systematics,,* 35**,** 491-522.

RIETVELD, E. & KIVERSTEIN, J. 2014. A rich landscape of affordances. *Ecological Psychology,* 26**,** 325-352.

RISJORD, M., DUNBAR, S. & MOLONEY, M. 2002. A new foundation for methodological triangulation. *Journal of Nursing Scholarship,* 34**,** 269-272.

ROBEYNS, I. 2011. The Capability Approach. *In:* ZALTA, E. N. (ed.) *The Stanford Encyclopedia of Philosophy.* Summer 2011 Edition ed. Stanford, CA: Stanford University.

RODRÍGUEZ, J. P., T. D. BEARD, J., BENNETT, E. M., CUMMING, G. S., CORK, S., AGARD, J., DOBSON, A. P. & PETERSON, G. D. 2006. Trade-offs across space, time, and ecosystem services. *Ecology and Society,* 11**,** 28.

ROE, J. & ASPINALL, P. A. 2011. The restorative benefits of walking in urban and rural settings in adults with good and poor mental health. *Health and Place,* 103-113.

ROSSO, A. L., AUCHINCLOSS, A. H. & MICHAEL, Y. L. 2011. The urban built environment and mobility in older adults: a comprehensive review. *Journal of Aging Research,* 816016.

RUPPRECHT, C. D. D. & BYRNE, J. A. 2014. Informal urban green-space: coparison of quantity and characteristics in Brisbane, Australia and Sapporo, Japan. *PLoSONE,* 9.

RUTLEDGE, D. 2003. Landscape indices as measures of the effects of fragmentation: can pattern reflect process? *DOC Science Internal Series 98*. Wellington, New Zealand: Department of Conservation.
RYAN, R. & DECI, E. 2001. On Happiness and Human Potentials: A Review of Research on Hedonic and Eudaimonic Well-Being. *Annual Review of Psychology,* 52**,** 141-166.
RYFF, C. A. K., C. 1995. The structure of psychological well-being revisited. *Journal of Personality and Social Psychology,* 69**,** 719-727.
SALLIS, J. F., BAUMAN, A. & PRATT, M. 1998. Environmental and policy interventions to promote physical activity. *American Journal of Preventive Medicine,* 15**,** 379-397.
SALLIS, J. F., CERVERO, R. B., ASCHER, W., HENDERSON, K. A., KRAFT, M. K. & KERR, J. 2006. An ecological approach to creating active living communities. *Annual Review of Public Health,* 27**,** 297-322.
SANDSTROM, U. G. 2002. Green infrastructure planning in urban Sweden. *Planning Practice and Research,* 17**,** 373-385.
SAUER, C. 1925. The Morphology of Landscape. *University of California Publications in Geography*. Berkeley, CA.
SAUNDERS, D., HOBBS, R. & MARGULES, C. 1991. Biological consequences of ecosystem fragmentation: a review. *Conservation Biology,* 5**,** 18-32.
SCHEWENIUS, M., MCPHEARSON, T. & ELMQVIST., T. 2014. Opportunities for increasing resilience and sustainability of urban social–ecological systems: Insights from the URBES, and the Cities and Biodiversity Outlook projects. *AMBIO: A Journal of the Human Environment*.
SCHIPPERIJN, J. & STIGSDOTTER, U. K. 2010. Influences on the use of urban green space - A case study in Odense, Denmark. *Urban Forestry & Urban Greening,* 9**,** 25-32.
SCHUELER, T. 1987. Controlling Urban Runoff: A Practical Manual For Planning And Designing Urban BMPs. Washington, DC: The Conservation Fund. MWCOG.
SCHULZE, E. D. & MOONEY, H. A. 1993. *Biodiversity and ecosystem function,* Berlin, Springer-Verlag.
SCOPELLITI, M. & VITTORIA GIULIANI, M. 2004. Choosing restorative environments across the lifespan: A matter of place experience. *Journal of Environmental Psychology,* 24**,** 423--437.
SCOTT, A. J. 2001. Globalization and the rise of city-regions. *European Planning Studies,* 9**,** 813-826.
SEAMAN, P. J., JONES, R. & ELLAWAY, A. 2010. It's not just about the park, it's about integration too: why people choose to use or not use urban greenspaces. *International Journal of Behavioral Nutrition and Physical Activity,* 7**,** 78.
SERVICE, U. S. N. P. 2015. *Guidelines for the Treatment of Cultural Landscapes* [Online]. US Department of the Interior. Available: HTTP://WWW.NPS.GOV/TPS/STANDARDS/FOUR-TREATMENTS/LANDSCAPE-GUIDELINES/TERMINOLOGY.HTM [Accessed January 12, 2015 2015].
SHACKELL, A. & WALTER, R. 2012. Greenspace design for health and well-being. *Forestry Commission Practice Guide.* Edinburgh, UK: Forestry Commission.
SHAW, D., AND SYKES, O. 2005. Addressing Connectivity in Spatial Planning: The Case of the English Regions. *Planning Theory & Practice,* 6**,** 11-33.
SINULINGGA, B. D. I. 2005. Pembangunan Kota (Tinajauan Regional dan Lokal). Jakarta: Pustaka Sinar Harapan.
SIPILÄ, M. & TYRVÄINEN, L. Integrating social and ecological information in planning at the urban fringe. *In:* QVISTRÖM, M., ed. The urban fringe in spatial planning - proceedings from a Nordic conference (Stadsnära landskap i samhällsplaneringen - meddelanden från en nordisk konferens), 2009. 35-42.
SILVA, C., 2015. Urban sprawl and interstitial spaces: a conceptual definition for undeveloped areas and their morphological implications in planning.

SMITH, M., MOSELEY, D., CHETCUTI, J. & DE LOANNI, M. 2008. Glasgow and Clyde Valley Integrated Habitat Networks Glasgow, Scotland: Forestry Commission.
SÖDERMAN, T., KOPPEROINEN, L., SHEMEIKKA, P. & YLI-PELKONEN, V. 2012. ECOSYSTEM SERVICES CRITERIA FOR SUSTAINABLE DEVELOPMENT IN URBAN REGIONS. *Journal of Environmental Assessment Policy and Management,* 14**,** 1250008.
SÖDERSTRÖM, B. & PÄRT, T. 2000. Influence of landscape scale on farmland birds breeding in semi-natural pastures. *Conservation Biology,* 14**,** 522-533.
SOUSA, M. 2014. Urban Landscape: Interstitial Spaces. *Landscape Review,* 13**,** 61-71.
SPANGENBERG, A. & KÖLLING, C. 2004. Nitrogen deposition and nitrate leaching at forest edges exposed to high ammonia emissions in Southern Bavaria. *Water, Air and Soil Pollution,* 152**,** 233–255.
STEINER, F. & BUTLER, K. 2012. *Planning and Urban Design Standards,* John Wiley & Sons.
STIGLITZ, J., SEN, A. & FITOUSSI, J. 2009. Report by the Commission on the Measurement of Economic Performance and Social Progress.
STILES, R., GASIENICA-WAWRYTKO, B., HAGEN, K., TRIMMEL, H., LOIBL, W., TÖTZER, T., KÖSTL, M., PAULEIT, S., SCHIRMANN, A. & FEILMAYR, W. 2014. Understanding the whole city as landscape. A multivariate approach to urban landscape morphology. *SPOOL,* 1.

STRIFE, S. & DOWNEY, L. 2009. Childhood development and access to nature: A new direction for environmental inequality research. *Organization & environment,* 22**,** 99-122.

SULLIVAN, W. C., KUO, F. E. & DEPOOTER, S. F. 2004. The fruit of urban nature –vital neighborhood spaces. *Environment and Behavior,* 35**,** 678-700.
SUTTON, M. & ANDERSON, E. 2004. *Introduction to Cultural Ecology,* AltaMira Press.
SVARSTAD, H., PETERSEN, L. K., ROTHMAN, D., SIEPEL, H. & WATZOLD, F. 2008. Discursive biases of the environmental research framework DPSIR. *Land Use Policy,* 25**,** 116-125.
SWANWICK, C., DUNNETT, N. & WOOLLEY, H. 2003. Nature, role and value of green space in towns and cities: An overview. *Built Environment* 94-106.
SWART, R. J., RASKIN, P. & ROBINSON, J. 2004. The problem of the future: sustainability science and scenario analysis. *Global environmental change,* 14**,** 137-146.
TATARKIEWICZ, W. 1962. *Analysis of Happiness,* Warsaw, Poland, Polish Scientific Publishers.
TAYLOR, A. F., KUO, F. E. & SULLIVAN, W. C. 2002. Views of nature and self-discipline: Evidence from inner city children. *Journal of Environmental Psychology,* 22**,** 49-63.
TAYLOR, P. Fragmentation and cultural landscapes: tightening the relationship between human beings and the environmen. *In:* CARSJENS, G. J., ed. Proceedings of the 3rd International Workshop on Sustainable Land Use Planning., 2000 Wageningen, The Netherlands. 17-25.
TAYLOR, P. D. 2002. Fragmentation and cultural landscapes: tightening the relationship between human beings and the environments. . *Landscape and Urban Planning***,** 93-99.
TEAM, U. 2004. Making greener cities - a practical guide. Leipzig, Halle, Germany: UFZ Centre for Environmental Research.
TENNESSEN, C. M. & CIMPRICH, B. 1995. Views to nature: Effects on attention. *Journal of Environmental Psychology,* 15**,** 77--85.
TERMORSHUIZEN, J. W. & OPDAM, P. 2009. Landscape services as a bridge between landscape ecology and sustainable development. *Landscape Ecology***,** 1037-1052.

THOMAS, J., C. MASER & RODIEK, J. E. 1979. Wildlife Habitats in Managed Forests: The Blue Mountains of Washington and Oregon. *In:* THOMAS, J. W. (ed.) *Edges.* Denver, CO: United States Forest Service.

THOMAS, P. A. 2011. Trajectories of social engagement and limitations in late life. *Journal of Health and Social Behavior,* 52**,** 430-443.

THOMPSON, G. F. & STEINER, F. R. 1997. *Ecological design and planning,* New York, NY, John Wiley & Sons, Inc.

TISDELL, C. 2000. Sustainability: The Economic Bottom Line, Working Paper No. 41S. *Economics, Ecology and the Environment.* The University of Queensland.

TODOROVA, A., ASAKAWA, S. & AIKOH, T. 2004. Preferences for and attitudes towards street flowers and trees in Sapporo, Japan. *Landscape and Urban Planning,* 69**,** 403--416.

TSAI, Y. H. 2009. Quantifying urban form: Compactness versus "sprawl". *Urban Studies***,** 141-161.

TSCHARNTKE, T., TYLIANAKIS, J. M., RAND, T. A., DIDHAM, R. K., FAHRIG, L., BATARY, P., BENGTSSON, J., CLOUGH, Y., CRIST, T. O. & DORMANN, C. F. 2012. Landscape moderation of biodiversity patterns and processes-eight hypotheses. *Biological Reviews,* 87**,** 661-685.

TURNER, B., KASPERSON, R., MATSON, P., MCCARTHY, J., CORELL, R., CHRISTENSEN, L., ECKLEY, N., KASPERSON, J., LUERS, M., MARTELLO, M., POLSKY, C., PULSIPHER, A. & SCHILLER, A. 2003. A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences,* 100**,** 8074-8079.

TURNER, I. & CORLETT, R. 1996. The conservation value of small, isolated fragments of lowland tropical rain forest. *Trends in Ecology & Evolution,* 11**,** 330–333.

TVEIT, M., ODE, A. & FRY, G. 2006. Key concepts in a framework for analysing visual landscape character. *Landscape Research,* 31**,** 229-256.

TYRVÄINEN, L., MÄKINEN, K. & SCHIPPERIJN, J. 2007. Tools for mapping social values of urban woodlands and other green areas. *Landscape and Urban Planning***,** 5–19.

TZOULAS, K., KORPELLA, K., VENN, S., YLI-PELKONEN, V., KAZMIERCZAK, A., NIEMELA, J. & JAMES, P. 2007. Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review. *Landscape and Urban Planning***,** 167-178.

UCHINO, B. N. 2006. Social support and health: A review of physiological processes potentially underlying links to disease outcomes. *Journal of Behavioral Medicine*.

UK, N. P. 2013. *Sustainable tourism and recreation.* [Online]. National Parks UK Association Official Website. Available: http://www.nationalparksengland.org.uk/home/policy/sustainable-tourism-and-recreation), [Accessed].

ULRICH, R. 1981. Natural vs. urban scenes: some psychophysiological effects. *Environment and Behavior,* 13**,** 523-556.

UMBERSON, D. & MONTEZ, J. K. 2010. Social relationships and health: A flashpoint for health policy. *Journal of Health and Social Behavior,* 51**,** S54-S66.

UN, U. N.-. 2012. World Population Prospects. New York, New York: United Nations Department of Economic and Social Affairs, Population Division.

UNEP, U. N. E. P.-. 2007. Global Environment Outlook: environment for development assessment *In:* MIRJAM SCHOMAKER, M. K., AND MUNYARADZI CHENJE (ed.). United Nations.

UNICEF, W. H. O. 2014. Trends in maternal mortality: 1990 to 2013: estimates by WHO, UNICEF, UNFPA, The World Bank and the United Nations Population Division: executive summary. Geneva, Switzerland: World Health Organization

UNION, T.-T. A. O. T. E. 2011. Territorial Agenda of the European Union 2020—Towards an Inclusive, Smart and Sustainable Europe of Diverse Regions. *In:* AGREED AT

THE INFORMAL MINISTERIAL MEETING OF MINISTERS RESPONSIBLE FOR SPATIAL PLANNING AND TERRITORIAL DEVELOPMENT ON 19TH MAY, H. (ed.). Brussels, Belgium: EU Commission.

USFS, U. S. F. S.-. 1995. Landscape Aesthetics: A Handbook for Scenery Management. *Agriculture Handbook No. 701*. U.S. Forest Service.

VÄHÄ-PIIKKIÖ, I. & OLLI MAIJALA, O. 2003. Helsinki Green Space. *Cost c11, Case study Helsinki.*

VALLÉS-PLANELLS, M., GALIANA, F. & VAN EETVELDE, V. 2014. A classification of landscape services to support local landscape planning. *Ecology and Society,* 1**,** 44.

VAN DILLEN, S., DE VRIES, S., GROENEWEGEN, P. & SPREEUWENBERG, P. 2012. Greenspace in urban neighbourhoods and residents' health: adding quality to quantity. *Journal of Epidemiology & Community Health,* 66.

VANDERMOTTEN, C., HALBERT, L., ROELANDTS, M. & CORNUT, P. 2008. European planning and the polycentric consensus: wishful thinking? *Regional Studies,* 42**,** 1205-1217.

VAN EETVELDE, V. & ANTROP, M. 2004. Analyzing structural and functional changes of traditional landscapes—two examples from Southern France. *Landscape and urban planning,* 67**,** 79-95.

VAN HERZELE, A. & WIEDEMANN, T. 2003. A monitoring tool for the provision of accessible and attractive urban green spaces. *Landscape and Urban Planning,* 63**,** 109-126.

VANOLO, A. 2010. European spatial planning between competitiveness and territorial cohesion: Shadows of neo-liberalism. *European Planning Studies,* 18**,** 1301-1315.

VARE, S. & REKOLA, L. 2007. Large contiguous forest areas as part of the ecological network of Uusimaa Region. Helsinki, Finland: Uusimaa Regional Council.

VINING, J., M.S. MERRICK & PRICE, E. A. 2008. The distinction between humans and nature: Human perceptions of connectedness to nature and elements of the natural and unnatural. *Human Ecology Review***,** 1-11.

VITOUSEK, P. M., MOONEY, H. A., LUBCHENCO, J. & MELILO, J. M. 1997. Human domination of earth's ecosystems. *Science***,** 494-499.

VOLKER, B., FLAP, H. & LINDENBERG, S. 2006. *When Are Neighborhoods Communities? Community in Dutch Neighborhoods.*

WALKER, B. & SALT, D. 2006. *Resilience Thinking: Sustaining Ecosystems and People in Changing World*, Washington, DC, Island Press.

WALKER, B. H. & LAWSON, R. L. 2006. Case studies in resilience: fifteen social-ecological systems across continents and societies. Stockholm, Sweden: The Resilience Alliance.

WANNOP, U. 1990. The Glasgow Eastern Area Renewal (GEAR) Project: A Perspective on the Management of Urban Regeneration. *The Town Planning Review,* 61**,** 455-474.

WARD THOMPSON, C. 2002. Urban open space in the 21st century. *Landscape and Urban Planning,* 60**,** 59-72.

WARD THOMPSON, C., ROE, J., ASPINALL, P., MITCHELL, R., CLOW, A. & MILLER, D. 2012. More green space is linked to less stress in deprived communities: Evidence from salivary cortisol patterns'. *Landscape and Urban Planning,* 105**,** 221-229.

WATER, S. 2015. *Sewers for Scotland* [Online]. Available: http://www.scottishwater.co.uk/assets/business/files/connections documents/sfsv4may2015pdf.pdf [Accessed November 5 2014].

WEBER, T., SLOAN, A. & WOLF, J. 2006. Maryland's Green Infrastructure Assessment: Development of a comprehensive approach to land conservation. *Landscape and Urban Planning,* 77**,** 94-110.

WEINSTOERFFER, J. & GIRARDIN, P. 2000. Assessment of the contribution of land use pattern and intensity to landscape quality: use of a landscape indicator. *Ecological Modelling,* 130**,** 95-109.

WELLS, N. M. & EVANS, G. W. 2003. Nearby nature – a buffer of life stress among rural children. Environment and Behavior**,** 3.

WESTHOFF, V. 1983. Man's attitude towards vegetation. *In:* **W. HOLZNER, M. J. A. W., I. IKUSIMA** (ed.) *Man's impact on vegetation.* The Hague: Junk.

WIENS, J. A. 2005. Toward a unified landscape ecology. *In:* WIENS JA, M. M. (ed.) *Issues and perspectives in landscape ecology.* Cambridge, UK: Cambridge University Press.

WHITBREAD, K. & ARKLEY, S. 2013. A Geodiversity Audit of the City of Glasgow.

WILSON, E. O. 1984. *Biophilia,* Cambridge, MA, Harvard University Press.

WITTEN, K., HISCOCK, R., PEARCE, J. & BLAKELY, T. 2008. Neighbourhood access to open spaces and the physical activity of residents: a national study. *Preventive medicine,* 47**,** 299-303.

WOODLEY, S., KAY, J. & FRANCIS, G. 1993. *Ecological Integrity and the Management of Ecosystems,* Ottawa, Canada, St. Lucie Press.

WU, J. 2006. Landscape ecology, cross-disciplinarity, and sustainability science. *Landscape Ecology***,** 1-4

WU, J. & HOBBS, R. 2007. *Landscape ecology: The state-of-the-science,* Cambridge, UK, Cambridge University Press.

WU, J., JENERETTE, G. D., BUYANTUYEV, A. & REDMAN, C. L. 2011. Quantifying spatiotemporal patterns of urbanization: The case of the two fastest growing metropolitan regions in the United States. *Ecological Complexity* 1-8.

WUYTS, K., SCHRIJVER, A., STAELENS, J., GIELIS, L., VANDENBRUWANE, J. & VERHEYEN, K. 2008. Comparison of forest edge effects on throughfall deposition in different forest types. ***Environmental Pollution****,* 153**,** 854-861.

YIN, R. K. 2003. *Case Study Research: Design and Methods,* Thousand Oaks, CA, Sage.

YLI-PELKONEN, V. & NIEMELÄ, J. 2005. Linking ecological and social systems in cities: urban planning in Finland as a case. *Biodiversity & Conservation,* 14**,** 1947-1967.

ZEISEL, J. 2006. *Inquiry by Design: Environment/Behavior/Neuroscience in Architecture, Interiors, Landscape and Planning,* New York, NY, Norton & Company, Inc.ZHANG, L., WU, J., ZHEN, Y. & SHU, J. 2004. RETRACTED: A GIS-based gradient analysis of urban landscape pattern of Shanghai metropolitan area, China. *Landscape and Urban Planning,* 69**,** 1-16.

ZHOU, X. & RANA, M. 2012. Social benefits of urbangreen space: A conceptual framework of valuation and accessibility measurements. *Management of Environmental Quality,* 23**,** 173-189.

ZONNEVELD, I. S. 1995. *Land ecology: an introduction to landscape ecology as a base for land evaluation, land management and conservation,* Amsterdam, The Netherlands, SPB Academic Publishing.

Transitional landscapes: Examining landscape fragmentation within peri-urban green spaces and its impacts upon human wellbeing

Richard le Brasseur

Appendices

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Declaration of Originality

I hereby declare that I have personally carried out the entire work described in this thesis and is my own original work and that it has not been submitted in whole or in part for any other degree or professional qualification. Due references have been provided on all supporting literatures and resources.



Richard John le Brasseur

9 June 2018

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Appendix 1 - Literature Review Results

1.1 Literature Review Results Introduction

The literature review was an ongoing process that provided input throughout every phase and methodology within this research. Not only serving as an academic critique of concepts and definitions and the empirical study of the literature available, the comprehensive literature review informed the decisions and implementation of approaches within the research procedure.

Significantly, the empirical study of the ecological performance of landscapes and green structures are well studied within literature, but human wellbeing performance is less so, especially when the epidemiological public health studies related to recreation, leisure, and psychology are removed. This literature review's assessment employed a comprehensive sample of recently published studies on green space and human wellbeing. A recent review by Bell et al. (2007) divided this literature into five general categories: health and wellbeing, social and community, environmental quality, economic values, and planning and design (including perceptions and preferences). Though environmental and economic facets within the human-green space relationship are important, it was the remaining three (3) aspects identified by Bell et al. (ibid) that were engaged within this research's goals and objectives.

1.1.1 Results and Trends in Literature

A Boolean search via Google Scholar (February 6, 2013) provided the following results:

Phrase 1: "ecology" + "green space" - 21,000 Results

Phrase 2A: "social well being" + "green space" - 1410 Results

Phrase 2B: "physical well being" + "green space" – 698 Results

Phrase 2C: "psychological well being" + "green space" - 1356 Results

Phrase 3: "human well being" + "green space" - 2060 Results

(Search included title or journal title, abstract, and/or keyword).

A similar SCOPUS (April 25, 2013) academic journal articles and document search within Title, Abstract and Keywords elicited the following (duplicate records not removed):

Phrase 1: "ecology" AND "green space" OR "greenspace" - 498 Results

(all Subject Areas as listed below)

Phrase 1: "ecology" AND "green space" OR "greenspace" - 108 Results

(Social Sciences & Humanities only)

Phrase 2A: " social well being " OR “social wellbeing” AND "green space" OR "greenspace" - 12 Results (all Subject Areas)

Phrase 2A: " social well being" OR “social wellbeing” AND "green space" OR "greenspace" - 5 Results (Social Sciences & Humanities only)

Phrase 2B: " physical well being " OR “physical wellbeing” AND "green space" OR "greenspace" - 1 Results (all Subject Areas)

Phrase 2B: " physical well being" OR “physical l wellbeing” AND "green space" OR "greenspace" - 0 Results

(Social Sciences & Humanities only)

Phrase 2C: " psychological well being " OR “psychological wellbeing” AND "green space" OR "greenspace" - 19 Results (all Subject Areas)

Phrase 2C: " psychological well being" OR “psychological wellbeing” AND "green space" OR "greenspace" - 4 Results

(Social Sciences & Humanities only)

Phrase 3: "human well being" OR “human wellbeing” AND "green space" OR “greenspace” - 421 Results (all Subject Areas)

Phrase 3: "human well being" OR “human wellbeing” AND "green space" OR “greenspace” - 74 Results (Social Sciences & Humanities only)

Note: SCOPUS Subject Areas included Health Sciences, Life Sciences, Physical Sciences, and Social Sciences & Humanities.

Other databases searched, but with no resultant metrics documented, included: Web of Knowledge, PubMed, and EBSCO. Overall, a majority of the research within green space and human wellbeing has been conducted since 2000, with many more publications resulting after this initial exploratory review (2013), which were reviewed. However, no date-range limitation was enacted in database inquiries, it should be noted that not all older papers may be full-text searchable, a limitation that may cause them to be underrepresented.

The literature review employed a semi-systematic review approach following Pickering and Byrne (2013). This method differs from a classic meta-analysis, as the results of the reviewed literature are not recoded and used as data for further statistical analysis. Alternatively, the preliminary information from peer reviewed papers and journal articles (published or in-press) was extracted through title and abstract review as well as key-word analysis. If the papers and articles had any relevance to the research topics, it was placed in themed folders for later comprehensive review. Overall, this semi-systematic review developed an efficient means to quickly identify theoretical and methodological trends in literature (Pickering and Byrne, 2013).

To broaden the review, the literature search then specifically targeted additional terms including ‘green space’, ‘landscape’, ‘environment’, and ‘socio-ecological’, for example, to look for additional potentially relevant publications not returned in the prior database searches (i.e. title, abstract, and key-words searches). This widened the results significantly. However, for further inclusion, the literature had to exhibit some aspect of the human-nature relationship such as ecosystem services, benefits, or quality of life or include spatial planning, green infrastructure, or urbanisation themes within its abstract.

Additional literature review techniques included Google Scholar, SCOPUS, and simple Google searches. Peer-reviewed journal articles were desirable, but books, chapters, papers, url’s, conference proceedings as well as research papers and reports as generated by Government departments, agencies, or public bodies and University-based research centres were reviewed.

Once the literature was preliminarily gathered and sorted into themed folders (e.g. human well being, green space, polycentricity, etc), they were imported into Mendeley Desktop. Mendeley Desktop (Version 1.10.1) is a web-based software program for organizing and managing research papers and literature. Each paper was subsequently placed into themed folders within Mendeley’s ‘Library’. Then, each

paper was reviewed in more depth and specific notations and comments were associated with each paper as enabled through the software. Specifically, research papers were systematically analysed for findings on the role of green space in human quality of life, study characteristics of individual research papers (year of publication, geographical location, green space typology, indicators, research methods, etc.), and publication trends across all research papers, such as temporal trends, journalistic patterns, studied green space types, methods used, and key authors. Principal and co-authorship was used to identify authors who contributed multiple research papers and their publication history was reviewed for additional literature.

Mendeley Desktop is cloud-based and works with many formats including PDF and Microsoft Word. Though Mendeley Desktop does provide a meta-analysis of publication metrics such as journal titles, abstracts, keywords, year, author, etc., it is limited by the original uploaded format. Specifically, it does not analyse and recode all required publication metrics faultlessly. Thus, a full and accurate measure of literature employed and publication trends in this research could not be determined. However, the following is a partial list of academic journals frequently utilised in the literature review, in no particular order:

Landscape and Urban Planning
Urban Forestry & Urban Greening
Journal of Environmental Psychology
Built Environment
Annual Review of Ecological Systems
Ecosystem Services
Journal of Environmental Management
Ecological Indicators
Ecological Economics
Frontiers in Ecology and the Environment
Urban Ecosystems
Environmental Management
Environment and Behavior
AMBIO: A Journal of the Human Environment
Ecological Psychology
Ecology and Society
Journal of the American Planning Association
Landscape Ecology

As the research progressed and concepts refined, additional literature searches were conducted both with and without database assistance throughout the research process. Google Scholar and SCOPUS searches with updated research terms were completed often.

1.2 Critical Literature Review Results

The literature review required a critical analysis of the collected, existing research in regards to their quality. Though no inclusion or exclusion criteria were established in the literature's initial assessment, only publications in English were considered and longitudinal studies were included.

Studies that explored the relationships between hazardous green space and/or negative human well-being were excluded; this research focussed on the benefits of green space to human well-being. Studies that focussed on children and/or pre-adolescents including 'play' and physical activity were also disregarded, unless they were assessed independently. Most green structure typologies were reviewed with a few exclusions such as remote wilderness areas, protected habitat, and small gardens; it was the facilitation of the human-nature interaction that was the important component. However, studies did not need a human-relationship component to them to be included; ecological indicators and biophysical characteristics were an important knowledge component of this research.

One limitation in analysing research papers and reports using this approach is the exclusion of non-English literature (Guitart et al., 2012; Roy et al., 2012). Though this research utilised Helsinki, Finland as one case study in which to gather data, English is the primary language of academia and research in Finland and no notable non-English literature was found to be critical to this review. However, this literature review recognised that it was not able to address papers published in other European languages (e.g. Dutch, French, Spanish, etc.) where similar issues exist and English is not the primary academic language. This is noted in the conclusion where an extended literature review in other languages was recommended.

1.3 Literature Review Results Summary

The literature review was updated as new empirical data, literature, and knowledge became available throughout the research process. As an exploratory process, the literature review had few constraints to gathering data; it was the critical analysis and synthesis of the data and knowledge, conducted by the researcher through multiple episodes of subjective evaluation, which ultimately produced the research herein.

Though existing research supports some green space characteristic relationships to quality of life (e.g. Jorgensen, Hitchmough and Calvert, 2002; Bjerke et al., 2006; Lillesand et al., 2004), the literature is limited and not specific to peri-urban green spaces within a fragmented context.

It is important to note that any literature review within interdisciplinary studies is constrained by the specific terminology and concepts commonplace to that discipline. Research on green space, the environment, and health is difficult primarily due to the differing terms used to describe the environment and green space in literature (Bell et al., 2008; Croucher et al., 2007). Croucher et al. (2007) applied systematic and complex review strategies for green space, yet, despite these searches, they were not able to identify all key studies cited by other authors: "*... it became clear as the review progressed that there is a wider literature covering many different aspects of greenspace ... there are particular challenges for those conducting reviews in complex health and social policy areas, where many different disciplines and agencies are investigating a variety of related themes and topics" (p4).*

Though this research's literature methodology had a wide and comprehensive approach, specifically in both Boolean operators and database resources, interdisciplinary literature often fails to capture the subtle nuances of detail and adequate description of greenspace, wellbeing, and other important concepts as required (Kaczynski et al., 2007). As such, frequent searching for new terms and multi-terms were conducted throughout the research process. This semi-systematic procedure surely missed some articles, but overall, the resultant collection of literature utilised in this research provided a thorough cross-section of the literature as well as inclusive of a number of key articles.

Additionally, within the keywords and terms mentioned prior, the search of reports and journal articles resulted in a significant greater quantity for the Helsinki/Finland case study over that for the Glasgow/Scotland. This can be attributed to the Finnish Government's strong support for these issues as well as the formal and academic recognition (OECD) that the Helsinki Metropolitan Region is polycentric, whereas the Glasgow Urban Region is not.

As stated, no meta-analysis was formulated. It is not known which Journals contributed the most citations to this research. As an interdisciplinary study, the results were diverse indicating a variety of journals and scholars share interest in this topic. However, it was noted that the breadth of literature on the topic of human

wellbeing and green space began in 2008 and has continued since. A reason for the increasing interest may be the continuing human development and urbanisation (UN-HABITAT, 2012) and the impacts that result, both anthropological and biological (e.g. nature-deficit disorder - Louv, 2008).

Appendix 2 - Statistically Significant Results and Relationships

2.1 The following tables report, more comprehensively, those results found within Section 9.7.2 and Tables 9.8 and 9.10 in order to clarify the research's findings and statements found within the discussion.

HWB BENEFIT	PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS LEVELS (Significant Results)	FRAGMENTATION CONTEXT
Psychological	SIZE	DENSITY	*(High) (p<0.0010)*	*MORE FRAG*
Psychological	PROXIMITY	COHERENCE	*(Integrated) (p<0.0006)*	*LESS FRAG*
Psychological	PROXIMITY	NEAREST NEIGHBOR	*(Connected)(p<0.0013)*	*LESS FRAG*
Psychological	PROXIMITY	ISOL & CONNVTY	*(Grouped) (p<0.050)*	*LESS FRAG*
Social	EDGE	DENSITY	*(Dense) (p<0.021)*	*MORE FRAG*
Physical	VEG STRUCTURE	DENSITY	*(Open) (p<0.017)*	*LESS FRAG*
Physical	MAINT & MGMT	CLEANLINESS	*(Moderate) (p<0.018)*	*n/a*

Table A2.1
PPUIGS Attribute Levels with Statistically Significant Relationships to HWB Affordances - Paisley CA

Overall, those HWB affordances with statistically significant PPUIGS characteristic's levels including those approaching predominantly show that a PUL landscape and PPUIGS with unfragmented qualities are more conducive to providing HWB benefits for the Paisley CA respondents.

HWB BENEFIT	PPUIGS CHARACTERISTIC	PPUIGS ATTRIBUTE	PPUIGS LEVELS (Significant Results)	FRAGMENTATION CONTEXT
Social	LEVEL OF GREEN	SETTING	*(Natural) (p<0.001)*	*LESS FRAG*
Social	LEVEL OF GREEN	VEG STRUCTURE - DENSITY	*(Open) (p<0.006)*	*LESS FRAG*
Social	LEVEL OF GREEN	VEG STRUCTURE - VERTICAL	*(Clustered) (p<0.018)*	*LESS FRAG*
Social	LEVEL OF GREEN	VEG STRUCTURE - HORIZONTAL	*(Uniform) (p<0.0013)*	*MORE FRAG*
Social	LEVEL OF GREEN	VEG STRUCTURE - VISIBILITY	*(Moderate) (p<0.037)*	*n/a*
Social	SIZE	LARGEST	*(Moderate) (p<0.018)*	*n/a*
Social	PROXIMITY	NEAREST NEIGHBOR	*(Connected) (p<0.014)*	*LESS FRAG*
Social	PROXIMITY	ISOL & CONNVTY	*(Grouped) (p<0.007)*	*LESS FRAG*
Social	EDGE	LONGEST EDGE	*(Least) (p<0.004)*	*MORE FRAG*
Social	EDGE	EDGE DENSITY	*(Transparent)(p<0.014)*	*LESS FRAG*
Social	SAFETY & SECUR	SAFETY	*(Safe) (p<0.001)*	*n/a*
Social	MAINT & MGMT	CLEANLINESS	*(Clean) (p<0.0012)*	*n/a*
Social	MAINT & MGMT	FACILITIES	*(Adequate) (p<0.002)*	*n/a*
Social	MAINT & MGMT	PATHS	*(Unpaved) (p<0.002)*	*n/a*
Social	MAINT & MGMT	SOCIABILITY	*(Mixed) (p<0.018)*	*n/a*
Physical	PROXIMITY	COHERENCE	*(Integrated)(p<0.003)*	*LESS FRAG*
Psychological	SHAPE	REGULATION - GREENESS	*(Natural) (p<0.035)*	*LESS FRAG*
Psychological	LEVEL OF GREEN	COMPOSITION - SETTING	*(Natural) (p<0.042)*	*LESS FRAG*
Psychological	MAINT & MGMT	SOCIABILITY	*(Mixed) (p<0.038)*	*n/a*
Psychological	MAINT & MGMT	PATHS	*(Mixed) (p<0.036)*	*n/a*

Table A2.2

PPUIGS Attribute Levels with Statistically Significant Relationships to HWB Affordances - Vantaa CA

Overall, those HWB affordances with statistically significant PPUIGS characteristic's levels including those approaching mostly, but not clearly, show that a PUL landscape and PPUIGS with unfragmented qualities are more conducive to providing HWB benefits for the Vantaa CA respondents.

It is important to note here - so as not to confound results - that these statistically significant results (Tables 9.8 and 9.10; Tables A2.1 and A2.2) are valid within their unique context of GS fragmentation and HWB. Overall, there were no statistically significant PPUIGS characteristics and attributes shared between the PPUIGS of the case study regions and the any of three HWB affordances.

However, this research took these significant results and added another layer of statistical analysis - the statistical trends toward levels of significance to better assess PPUIGS impacts to HWB within each case study area (Reported in Tables 9.12 and 9.13). This, statistically, adds strength to the relationships, is valid, and more reflective of each case study area's urbanising, transitional landscape and the dynamics of GS fragmentation. As such, it is these results (Significance + Trend) which are primarily reported and discussed (Reported in Tables 9.12 and 9.13).

Stated another way, the statistically significant results (Tables 9.8 and 9.10; Tables A2.1 and A2.2) overall, and generally, report both CA's PPUIGS with unfragmented qualities are more conducive to providing HWB benefits for respondents. However, this research indicates multiple trends towards the likelihood of receiving a HWB benefit through interaction with a PPUIGS GS that exhibits the physical characteristics of landscape fragmentation, and these are the focus of results, findings and discussion.

In summary, these statistically significant trend results indicate respondents for both CAs received psychological HWB affordances from naturalistic and physically connected PPUIGS, social HWB affordances from PPUGS with edge effects, and physical HWB affordances from linear shaped GS.

Appendix 3 - Case Study – Land Cover Analysis Data Recoding

The land cover analysis at both Class Level 1and Class Level 2 provided important quantitative information on both the levels of urbanisation and GS within the catchment areas. In order to view the most straightforward delineation of the green structures in the catchment area, the land cover's GIS data was re-coded.

The data source for the Scotland data was the European Nature Information System. The data source for the Finland data was the The European Environment Agency.

Where data received was not classified as standardised CORINE Levels (e.g. EUNIS), it was modified to correlate to the best possible Class Level. For example, Level 2 Classes place some green structure elements within Class 1 Artificial Surfaces such as 'Green urban areas' and 'Golf courses' in Level 3 and Level 4 respectively. For consistency and clear analysis of green structures, Class 2 'Artificial nonagricultural vegetated areas', considered a Class 1 'Artificial Surface', was manually recoded to be Class 1 'Forests and semi-natural areas' and within its subsequent Class 2 'Open spaces with little or no vegetation'.

Lastly, Class 2 places 'Pastures' within the Class 1 'Agricultural Areas'. However 'Grasslands' is a common land cover and planning term utilised in Scotland and the UK when referring to agricultural lands, often used in place of or additional to 'Pastures'. Thus, both case study regions had their Class 2 'Pastures' recoded to read 'Pastures and Grasslands' to minimise confusion and enhance legibility across contexts.

All water typologies were removed form the land cover analysis and were not considered part of the total land area, though regarded as part of the CA.

Appendix 4 - Case Study – FRAGSTATS Landscape Analysis Procedure

4.1 FRAGSTATS Landscape Fragmentation Metrics

In spatial analysis, landscape metrics (Mandelbrot, 1983) or, so-called spatial metrics, are numerical measurements that quantify spatial patterns within the landscape, including such characteristics such as compactness, edge and shape of land use patches or spaces within a geographic area. These patches create a pattern upon the landscape that is both visible and measurable.

Measures of landscape fragmentation analyse the extent of fragmentation as the degree to which fragmentation has taken place within a specified spatial scale, whereas the *pattern* of landscape fragmentation describes patch geometry, including size, shape, distribution and configuration. This quantification can be assessed at multiple scales such as patch-level, class-level or landscape-level (McCarigal et al., 2002).

Scale is important when considering landscapes and varies according to the study and the phenomenon under consideration. A smaller scale (or grain, referring to the smallest size of GIS spatial data) should yield more accurate results. It is noted, however, that studies examining the same ecological phenomena using different scales have led to differing results, invalidating comparisons between them (Wiens, 1989).

The literature divides landscape metrics into two distinct groupings: composition and configuration (Li, 1993; Gustafson, 1998). The composition of a landscape pattern is the quantity and proportion of 'ingredients' that make up the landscape mosaic. Configuration, meanwhile, refers to the spatial pattern (i.e. arrangement) of patches in the landscape (Li, 1993).

Fragmentation affects many physical and structural aspects of the landscape (i.e. patches) that often form the basis for measurement and are commonly categorised through various indices. Overall, the literature confirms the measurement of landscape fragmentation through an index of varied measures rather than a single indicator or measure.

Landscape metrics are based on the quantification of (i.e. nonspatial) composition and spatial configuration (Gustafson 1998) and include the analysis of the variety and abundance of a specific pattern for the patches/elements within the

landscape as well as their aggregation, arrangement and position. However, as noted prior, these metrics do not refer to ecological functions or processes (McGarigal and Marks, 2002), these are referred to as functional metrics or structural metrics, and are specifically relevant to a particular organism or process of study and are explicitly measured (i.e. not indexed).

As with all metrics, no agreement in the literature about which criterion / validity index is best to apply (Milligan & Cooper, 1985; Pal & Bezdek, 1995; Kim et al., 2004). Each index makes a different assumption about structure it is advisable not to rely on any single index but compare several (Everitt et al., 2001). As Pal and Bezdek (1995) reminded, *"no matter how good your index is, there is a dataset out there waiting to trick it (and you)"* (p. 153). In view of the weaknesses of formal validation techniques Baxter (1994) concluded, *"…informal and subjective criteria, based on subject expertise, are likely to remain the most common approach"* (p.167).

4.2 FRAGSTATS Parameters

This research's application of FRAGSTATS utilised a hierarchy of scales or levels in its analysis. The following analysis parameters were applied to patch, class, and landscape level metrics (See Table X.x):

Edge Depth = 10m (fixed);
Threshold Distance = 15m;
Similarity Index = 0.5 for all;
Contrast Index = 0.5 for all metrics;
Search Radius = 200m.

Table A4.1
FRAGSTATS Landscape Analysis Metric Paramaters

Edge Depth = 10m (fixed)

This research made edge depth a constant metric for all classes at all edges (not variable per class or per edge metric). Edge depth is often modified for differing landscape classes, such as an as an artificial surface and a forest, however, theoretically, in a socio-ecological landscape, there should be no variation. This research selected 10 m as this is a socio-ecological edge depth: 10 m is the distance

where an individual can see a green space across a typical neighborhood two-land road and access it. 10 m also is an adequate distance for many aspects of functional habitat connectivity (10 m was used for forest patches in Wales, UK (J. Latham, J. Sherry & J. Rothwell; 2013 Wales) and was a functional threshold for 10 m of terrestrial amphibians in Switzerland (Churko, 2016) for patches, as well as seed dispersal (Martino, 2015).

From an ecological functional standpoint, further study is needed to create effective edge depths - as the habitat for a forest varies per other ecological characteristics, just as socio-cultural characteristics. Specific contexts require specific metrics, this edge depth is considered appropriate for this research.

Threshold Distance = 15m

Threshold distance measures the physical connectivity of patches through its given distance, here GS. Ecologically, functional connectivity is key to ecological integrity, and varying species and habitats (i.e. patches) have varying distances. This research selected 15 m as the threshold distance for FRAGSTAT metrics as this is considered a typical roadway size in peri-urban regions. Though many ecological impacts are associated with road development, including changes in soil and vegetation composition, water balance, and local climate, air pollution and public health (Forman et al., 2003; Coffin, 2007), 15 m represents both a visual connectivity and simple, accessible physical connectivity metrics for GS interaction by individuals.

Similarity Index = 0.5 for all

The similarity index quantifies the spatial context of the patches in question in relation to similar nearby patches. A parameter of 0.5 is considered standard and allows smaller and disconnected patches to be identified which would normally be disregarded in other metrics through its search radius. Thus, the similarity index is a more comprehensive measure of patch isolation than the proximity index for GS.

Contrast Index = 0.5 for all metrics

The similarity index quantifies the spatial context of the patches in question in relation to the larger landscape. Many of the metrics included include contrast analyses that measure the level of difference between adjacent patches. A parameter

of 0.5 is considered standard and allows the adjacent patches to be adequately recognized.

Search Radius = 200m

The search radius measures the connectivity of patches through its given distance, here GS. Similar to buffer, the search radius within FRAGSTATS considered a patch connected if it was within 200m. This distance is considered a 5 minute walking distance, thus multiple GS can be linked to one another by the. This distance has been used in other GS studies as a measure of minimum accessibility standards (e.g. Green health, Hutton institute; Ngom et al., 2016; Gupta, 2012). 200m represents a physical connectivity distance moreso than visual, though both are important in facilitating GS interaction.

4.3 FRAGSTATS Procedure

The same European Environment Agency standard of CORINE land cover as applied in the land cover analysis was utilised here, both Level I and Level II Classes were analysed. The vector data from ArcGIS (ArcView Shape files) were converted to raster format (ArcView Grids) with the same extent and same geographic coordinates at the pixel size of 10m x 10m then integrated into FRAGSTATS. Land use classification already occurred in the land cover analysis so no recoding was required for the FRAGSTATS analysis. All water typologies were removed from the fragmentation analysis where possible.

FRAGSTATS conducts spatial analysis on raster based data (i.e. maps) using landscape metrics. The program is not scale dependent for use, and the output from the metrics is in metres for distance-based metrics, and hectares for area-based metrics. The data input is a raster image such as Arc Grid (a data type from ArcGIS), or an ASCII, BINARY, ERDAS or IDRISI image file, and the program allows specific landscape metrics, e.g. size, shape, edge, etc., of various patches (i.e. selected individual land cover typology) and classes that indicate landscape composition.

There are copious GIS methodologies that can be employed to analyse landscape fragmentation and/or connectivity. Many of these, however, focus on forestry, habitat and/or ecological integrity aspects, and are suited to larger scales (i.e. landscape level) and ecological-based science studies. GIS-based landscape fragmentation analysis has spurred the development of various landscape indices and

software packages, such as FRAGSTATS, Patch Analyst, or the r.le module for GRASS. Additionally, various spatial metrics have also been integrated into existing geographic information system (GIS) software (e.g., Patch Analyst in ArcView; and module Pattern in IDRISI). Each provides a thorough analysis of landscape fragmentation, and even utilise similar indicators; it is the ease of use that separates these software packages from one another. FRAGSTATS is considered the most comprehensive, commonly used, and user-friendly program available when analysing landscape fragmentation through GIS.

4.4 FRAGSTATS Metadata Results

The following Tables provide the FRAGSTATS Analysis Metadata results.

METRIC	P - Binary CA	P - Binary 10K EXTENSION
TA	7928.12	79009.32
NP	3352	18434
PD	42.2799	23.3314
LPI	66.7376	33.0933
TE	985780	7951780
ED	124.3397	100.6436
AREA_MN	2.3153	4.1586
AREA_AM	3653.7995	17162.9601
AREA_MD	0.08	0.08
AREA_RA	5291	26146.76
AREA_SD	91.9471	267.1256
AREA_CV	3971.2866	6423.4961
SHAPE_MN	1.2627	1.3084
SHAPE_AM	25.8372	51.9491
SHAPE_MD	1	1
SHAPE_RA	34.8874	109.2622
SHAPE_SD	0.7812	1.037
SHAPE_CV	61.8672	79.2548
FRAC_MN	1.0524	1.0593
FRAC_AM	1.3359	1.3676
FRAC_MD	1.0176	1.0294
FRAC_RA	0.4027	0.4853
FRAC_SD	0.0655	0.068
FRAC_CV	6.2273	6.415
PARA_MN	1620.2597	1537.6511
PARA_AM	277.4325	224.992
PARA_MD	2000	1500
PARA_RA	1887.033	1920.808
PARA_SD	448.1152	461.9916
PARA_CV	27.657	30.0453
CONTIG_MN	0.1679	0.2035
CONTIG_AM	0.8515	0.8785
CONTIG_MD	0.1292	0.1667
CONTIG_RA	0.9347	0.9566
CONTIG_SD	0.2003	0.2081
CONTIG_CV	119.3129	102.2394
TCA	7760.88	76659.08
NDCA	3352	18434
DCAD	42.2799	23.3314
CORE_MN	2.3153	4.1586
CORE_AM	3653.7995	17162.9601
CORE_MD	0.08	0.08
CORE_RA	5291	26146.76
CORE_SD	91.9471	267.1256
CORE_CV	3971.2866	6423.4961
PROX_MN	833.6713	13572.3374
PROX_AM	393.9947	22782.4894
PROX_MD	6.7646	13.9209
PROX_RA	33144.588	163574.0222
PROX_SD	4454.1518	37253.772
PROX_CV	534.2815	274.4831
SIMI_MN	63630.9298	312703.8027
SIMI_AM	41569.0055	437723.955
SIMI_MD	66140.9005	326839.4973
SIMI_RA	67707.9456	615966.8087
SIMI_SD	11813.0295	65544.646
SIMI_CV	18.5649	20.9606
ENN_MN	52.008	50.5876
ENN_AM	40.9571	40.5247
ENN_MD	44.7214	44.7214
ENN_RA	333.6308	1174.9074
ENN_SD	19.5367	26.7754
ENN_CV	37.5649	52.9288
CWED	62.1698	50.3218
TECI	41.8512	42.7274
ECON_MN	48.531	49.0173
ECON_AM	44.7537	43.3332
ECON_MD	50	50
ECON_RA	50	50
ECON_SD	5.6029	4.4956
ECON_CV	11.545	9.1715
CONTAG	28.3222	29.1106
PLADJ	86.1284	88.7504
IJI	N/A	N/A
CONNECT	0	0
COHESION	99.6901	99.8556
DIVISION	0.5489	0.7892
PR	2	2
PRD	0.0252	0.0025
RPR	66.6667	66.6667
SHDI	0.6213	0.6525
SIDI	0.4299	0.4599
MSIDI	0.5619	0.616
SHEI	0.8963	0.9414
SIEI	0.8598	0.9198
MSIEI	0.8107	0.8887
AI	86.3976	88.8398

Table A4.2
FRAGSTATS Analysis Metrics
Paisley, Scotland – Binary Results, CA and 10K

METRIC	P - Class Lv II CA	P - Class Lv II 10K EXTENSION
TA	7928.12	77988.92
NP	7532	69184
PD	95.0036	88.71
LPI	36.618	18.3932
TE	2785580	16896480
ED	351.3544	216.6523
AREA_MN	1.0304	1.0886
AREA_AM	1095.8175	2844.1639
AREA_MD	0.08	0.08
AREA_RA	2903.08	14344.6
AREA_SD	33.5865	55.6317
AREA_CV	3259.6014	5110.5344
SHAPE_MN	1.411	1.3272
SHAPE_AM	39.1998	39.3055
SHAPE_MD	1	1
SHAPE_RA	96.6271	189.005
SHAPE_SD	1.4758	0.9383
SHAPE_CV	104.5904	70.6948
FRAC_MN	1.0646	1.0635
FRAC_AM	1.326	1.2461
FRAC_MD	1.0345	1.0406
FRAC_RA	0.5332	0.5588
FRAC_SD	0.0775	0.0697
FRAC_CV	7.2775	6.5558
PARA_MN	1518.6452	1513.83
PARA_AM	741.2458	494.6287
PARA_MD	1500	1500
PARA_RA	1897.3384	1953.8616
PARA_SD	488.1587	491.936
PARA_CV	32.1444	32.4961
CONTIG_MN	0.2145	0.2185
CONTIG_AM	0.6053	0.733
CONTIG_MD	0.1667	0.1667
CONTIG_RA	0.9405	0.9743
CONTIG_SD	0.2222	0.2259
CONTIG_CV	103.5812	103.387
TCA	7760.88	75311.52
NDCA	7532	69184
DCAD	95.0036	88.71
CORE_MN	1.0304	1.0886
CORE_AM	1095.8175	2844.1639
CORE_MD	0.08	0.08
CORE_RA	2903.08	14344.6
CORE_SD	33.5865	55.6317
CORE_CV	3259.6014	5110.5344
PROX_MN	1031.1634	2495.3444
PROX_AM	352.5506	2749.4029
PROX_MD	6.0992	5.3416
PROX_RA	18210.3495	89770.5431
PROX_SD	3939.4143	13700.8894
PROX_CV	382.0359	549.0581
SIMI_MN	30574.4774	130234.4116
SIMI_AM	43614.0711	140692.0245
SIMI_MD	36322.7251	179317.4844
SIMI_RA	57955.1606	359100.6561
SIMI_SD	10994.9104	77020.8314
SIMI_CV	35.9611	59.1402
ENN_MN	57.0418	57.4215
ENN_AM	51.9895	62.2613
ENN_MD	44.7214	40
ENN_RA	4345.1568	4221.1735
ENN_SD	79.4306	74.6942
ENN_CV	139.2498	130.0804
CWED	175.6772	108.3262
TECI	46.7768	41.3398
ECON_MN	48.227	47.0544
ECON_AM	48.0077	43.8161
ECON_MD	50	50
ECON_RA	50	50
ECON_SD	5.7899	5.7717
ECON_CV	12.0056	12.266
CONTAG	46.4693	43.1151
PLADJ	62.9377	75.2686
IJI	40.6802	59.646
CONNECT	0	0
COHESION	99.2814	99.444
DIVISION	0.8647	0.9648
PR	10	11
PRD	0.1261	0.0141
RPR	333.3333	366.6667
SHDI	1.5293	1.9553
SIDI	0.7319	0.8301
MSIDI	1.3164	1.7728
SHEI	0.6642	0.8154
SIEI	0.8132	0.9132
MSIEI	0.5717	0.7393
AI	63.2952	75.4278

Table A4.3
FRAGSTATS Analysis Metrics
Paisley, Scotland – Class Level II Results, CA and 10K

METRIC	V - Binary - CATCHMENT AREA	V-Binary - 10k EXTENSION
TA	13085.72	97456.88
NP	2193	10878
PD	16.7587	11.1619
LPI	49.9653	26.2277
TE	1158220	6127500
ED	88.5102	62.874
LSI	5.868	50.3109
AREA_MN	3568.3827	7.2854
AREA_AM	0.08	9085.6425
AREA_MD	6538.28	0.24
AREA_RA	144.5855	25560.68
AREA_SD	2463.9506	257.1765
AREA_CV	1.2541	3530.0105
SHAPE_MN	20.0774	1.2634
SHAPE_AM	1	28.6001
SHAPE_MD	33.4858	1
SHAPE_RA	0.9128	78.3164
SHAPE_SD	72.7905	0.9147
SHAPE_CV	1.0437	72.399
FRAC_MN	1.3017	1.046
FRAC_AM	1.0176	1.2685
FRAC_MD	0.3935	1.0176
FRAC_RA	0.0571	0.4518
FRAC_SD	5.4682	0.0552
FRAC_CV	1390.3563	5.2753
PARA_MN	192.6736	1163.1484
PARA_AM	1500	166.4632
PARA_MD	1933.9356	1125
PARA_RA	584.9595	1965.6371
PARA_SD	42.0726	601.8441
PARA_CV	0.2659	51.7427
CONTIG_MN	0.8893	0.3725
CONTIG_AM	0.1667	0.9037
CONTIG_MD	0.9617	0.3681
CONTIG_RA	0.2731	0.9797
CONTIG_SD	102.7151	0.2866
CONTIG_CV	12868.6	76.9445
TCA	2193	79250.92
NDCA	16.7587	10878
DCAD	5.868	11.1619
CORE_MN	3568.3827	7.2854
CORE_AM	0.08	9085.6425
CORE_MD	6538.28	0.24
CORE_RA	144.5855	25560.68
CORE_SD	2463.9506	257.1765
CORE_CV	2681.3953	3530.0105
PROX_MN	1668.4928	10670.0398
PROX_AM	117.0656	12332.8648
PROX_MD	40910.817	64.8342
PROX_RA	8122.5277	159807.583
PROX_SD	302.9217	33882.8587
PROX_CV	74841.4153	317.5514
SIMI_MN	78539.9468	236003.917
SIMI_AM	81753.9477	401790.2916
SIMI_MD	85993.8771	319516.7097
SIMI_RA	20983.9177	614144.0111
SIMI_SD	28.0378	132252.5261
SIMI_CV	60.324	56.0383
ENN_MN	41.0885	65.499
ENN_AM	44.7214	42.9072
ENN_MD	513.1727	44.7214
ENN_RA	35.0187	3739.1533
ENN_SD	58.0511	68.4161
ENN_CV	44.2551	104.4537
CWED	43.5598	31.437
TECI	47.4289	43.0656
ECON_MN	45.4487	47.1284
ECON_AM	50	45.689
ECON_MD	50	50
ECON_RA	7.6692	50
ECON_SD	16.17	9.3963
ECON_CV	28.1846	19.9376
CONTAG	90.3663	33.4984
PLADJ	N/A	91.6768
IJI	0	N/A
CONNECT	99.6964	0
COHESION	0.7318	99.78
DIVISION	2	0.9242
PR	0.0153	2
PRD	66.6667	0.0021
RPR	0.6918	100
SHDI	0.4987	0.6522
SIDI	0.6905	0.4597
MSIDI	0.9981	0.6155
SHEI	0.9973	0.941
SIEI	0.9962	0.9193
MSIEI	90.5922	0.888
AI		91.7678

Table A4.4
FRAGSTATS Analysis Metrics
Vantaa, Finland – Binary Results, CA and 10K

METRIC	P - Class Lv II CA	P - Class Lv II 10K EXTENSION
TA	13085.72	97451.24
NP	10008	55598
PD	76.4803	57.0521
LPI	17.4584	10.9279
TE	2249660	13080800
ED	171.9172	134.2292
AREA_MN	1.2858	1.4253
AREA_AM	470.2676	1727.565
AREA_MD	0.08	0.12
AREA_RA	2284.52	10649.32
AREA_SD	24.5567	49.6015
AREA_CV	1909.7915	3480.0128
SHAPE_MN	1.2037	1.2197
SHAPE_AM	10.4426	15.9468
SHAPE_MD	1	1
SHAPE_RA	43.8536	92.1366
SHAPE_SD	0.6043	0.6
SHAPE_CV	50.2036	49.1954
FRAC_MN	1.0416	1.0443
FRAC_AM	1.2051	1.212
FRAC_MD	1.0176	1.0176
FRAC_RA	0.4489	0.4906
FRAC_SD	0.0544	0.0559
FRAC_CV	5.2189	5.3536
PARA_MN	1451.7325	1396.0331
PARA_AM	362.302	342.1049
PARA_MD	1500	1500
PARA_RA	1902.0867	1935.3998
PARA_SD	564.5945	568.5039
PARA_CV	38.8911	40.7228
CONTIG_MN	0.24	0.2659
CONTIG_AM	0.7955	0.8071
CONTIG_MD	0.1667	0.1667
CONTIG_RA	0.9449	0.9614
CONTIG_SD	0.2614	0.2642
CONTIG_CV	108.9026	99.3735
TCA	12868.6	79245.28
NDCA	10008	55598
DCAD	76.4803	57.0521
CORE_MN	1.2858	1.4253
CORE_AM	470.2676	1727.565
CORE_MD	0.08	0.12
CORE_RA	2284.52	10649.32
CORE_SD	24.5567	49.6015
CORE_CV	1909.7915	3480.0128
PROX_MN	255.9845	885.8627
PROX_AM	509.2637	2212.9471
PROX_MD	3.1064	2.7299
PROX_RA	14426	66571.9444
PROX_SD	1433.1587	5734.6902
PROX_CV	559.8614	647.3566
SIMI_MN	16024.7007	60043.4347
SIMI_AM	41013.5223	186245.1392
SIMI_MD	28559.721	16936.7028
SIMI_RA	109542.4778	675352.0601
SIMI_SD	13362.1474	62280.5556
SIMI_CV	83.3847	103.7258
ENN_MN	71.4799	77.5384
ENN_AM	59.1489	61.8504
ENN_MD	44.7214	44.7214
ENN_RA	3215.8255	8175.7166
ENN_SD	106.5402	126.6945
ENN_CV	149.0491	163.3958
CWED	85.9586	67.1146
TECI	46.4633	46.456
ECON_MN	48.1211	48.2889
ECON_AM	48.3833	48.2293
ECON_MD	50	50
ECON_RA	50	50
ECON_SD	6.251	6.2762
ECON_CV	12.9902	12.9971
CONTAG	51.5728	52.0814
PLADJ	81.8849	82.8948
IJI	57.8961	60.7682
CONNECT	0	0
COHESION	98.4434	98.9996
DIVISION	0.9647	0.9856
PR	12	12
PRD	0.0917	0.0123
RPR	400	85.7143
SHDI	1.7199	1.711
SIDI	0.7803	0.766
MSIDI	1.5155	1.4526
SHEI	0.6921	0.6886
SIEI	0.8512	0.8357
MSIEI	0.6099	0.5846
AI	82.2712	83.051

Table A4.5
FRAGSTATS Analysis Metrics
Vantaa, Finland – Class Level II Results, CA and 10K

4.5 FRAGSTATS Results Post –Hoc Adjustments

After a review and brief analysis of the FRAGSTATS results, it was determined that the Class Level I data and the Class Level II data were, ratio-based, very similar when compared to one another, and also very similar to the Binary output. As such, Level I data was removed from further analysis.

Binary is a simple classification analysis that captured the impervious, artificial landscape classes vs. the pervious, natural landscape classes (i.e. grey vs. green) and provides a quick, simple overview of fragmentation metrics. Only certain metrics could be analysed within the binary context.

Additionally, it was determined that certain FRAGTATS metrics and indices overlapped with others within the results. Spatial analysis is a tool to explain a phenomenon, here landscape fragmentation. As such, spatial analysis can be affected by the goal of the research as well as the interpretation of the data (Gustafson, 1998; Turner et al., 2003). The scale of the data analysed can impact results and interpretation (Riitters, 1995). Many spatial indices overlap data (Mander et al., 2005; Uueema 2009) and similar terminologies are applied within different disciplines (McGarigal et al., 2002; Fernandez et al., 2007), creating difficulty in accurate interpretation. Because of landscape fragmentation's dynamism, Herold, Scepan, and Clarken (2002) cautioned against causal interpretation.

In this study, the landscape fragmentation metrics overlap one another and often tell the same information, just from a different metric perspective (e.g. connectivity vs. fragmentation). Table A4.6 shows the FRAGSTAT metrics that were removed from analysis and the reasons noted.

Percentage of Landscape (PLAND) - SAME AS LAND CLASS
Total Core Area (TCA) - REPETITIVE
Core Area Percentage of Landscape (CPLAND) - REPETITIVE
Disjunct Core Area Density (DCAD) - REPETITIVE

Perimeter Area Ratio Index (PARA) - REPETITIVE
Patch Richness (PR) SAME AS LAND CLASS
Relative Patch Richness (RPR) - SAME AS LAND

Shannon's Evenness Index (SIEI) REPETITIVE
Modified Shannon's Evenness Index (MSIEI) REPETITIVE
Modified Simpson's Diversity Index (MSIDI) REPETITIVE
Modified Simpson's Evenness Index (MSHEI) REPETITIVE
Simpson's Evenness Index (SHEI)

Landscape Division Index (DIVISION) - REPETITIVE
Clumpiness Index (CLUMPY) -REPETITIVE
Nearest Neighbour (NN) - REPETITIVE

Edge Density (ED) - REPETITIVE
Total Edge Contrast Index (TECI) - REPETITIVE

Table A4.6
Removed FRAGSTATS Metrics

After the results were tabulated, it was decided that the results would be simplified and organised into two separate categories of interpretation: Case Study Area Analysis (CAA) and Comparative Analysis (COMPARATIVE). These are noted in Table A4.7 below:

Size	**Area - Density - Largest**
	Patch Core Area Index (CORE) **COMPARATIVE**
	Area Index (AREA) **COMPARATIVE - patch metrics**
	Total Area (TA) **COMPARATIVE - landscape metrics**
	Total (Class) Area (CA) **COMPARATIVE - class metrics**
	Number of Patches (NP) **COMPARATIVE - class metrics**
	Largest Patch Index (LPI) **COMPARATIVE - class metrics**
	Number of Disjunct Core Areas (NDCA) - **COMPARATIVE - class metrics**
	Patch Density (PD) - **CAA - class metrics**
Shape	**Regulation - Complexity & Diversity - Typology**
	Fractal Dimension Index (FRAC) **- CAA**
	Shape Index (SHAPE) - **CAA**
	Patch Richness Density (PRD) **COMPARATIVE**

	Shannon's Diversity Index (SHDI) - **CAA**
	Simpson's Diversity Index (SIDI) - **CAA**
Proximity	**Nearest Neighbour - Isolation & Connectivity**
	Similarity Index (SIMI) - **COMPARATIVE**
	Proximity Index (PROX) - **COMPARATIVE**
	Contiguity Index (CONTIG) - **CAA**
	Patch Cohesion Index (COHESION) - **CAA**
	Interspersion & Juxtaposition Index (IJI) - **CAA and Comparative**
	Percentage of Like Adjacencies (PLADJ) - **COMPARATIVE**
	Contagion (CONTAG) - **CAA and Comparative**
	Euclidean Nearest Neighbor Index (ENN) **CAA**
Edge	**Total Edge - Longest Edge - Edge Density**
	Edge Contrast Index (ECON) - **COMPARATIVE**
	Total Edge (TE) - **CAA**
	Contrast-Weighted Edge Density (CWED) - **COMPARATIVE**

Table A4.7
Applied FRAGSTAT Metrics

Furthermore, some metrics were better suited to comparative analysis (i.e. between two individual CAs - See Table A4.9) than individual CAs (See Table A4.8).

Size	**Area - Density - Largest**
	Patch Density (PD)
Shape	**Regulation - Complexity & Diversity – Typology**
	Shape Index (SHAPE)
	Fractal Dimension Index (FRAC)
	Shannon's Diversity Index (SHDI)
	Simpson's Diversity Index (SIDI)
Proximity	**Nearest Neighbour - Isolation & Connectivity**
	Contiguity Index (CONTIG)
	Patch Cohesion Index (COHESION)
	Euclidean Nearest Neighbor Index (ENN)
Edge	**Total Edge - Longest Edge - Edge Density**
	Total Edge (TE)

Table A4.8
Individual Case Study Area Fragmentation Metrics

Size	**Area - Density - Largest**

	Patch Core Area Index (CORE)
	Area Index (AREA)
	Total Area (TA)
	Total (Class) Area (CA)
	Number of Patches (NP)
	Largest Patch Index (LPI)
Shape	**Regulation - Complexity & Diversity – Typology**
	Patch Richness Density (PRD)
Proximity	**Nearest Neighbour - Isolation & Connectivity**
	Similarity Index (SIMI)
	Proximity Index (PROX)
	Interspersion & Juxtaposition Index (IJI)
	Percentage of Like Adjacencies (PLADJ)
	Contagion (CONT)
Edge	**Total Edge - Longest Edge - Edge Density**
	Edge Contrast Index (ECON)
	Contrast-Weighted Edge Density (CWED)

Table A4.9
Comparative Case Study Area Fragmentation Metrics

4.6 FRAGSTATS Analysis Results Limitations

There are many potential limitations to be found within the FRAGSTATS analysis and results. First, the data must be of high quality with minimal GIS data errors. This particular fragmentation analysis method was limited by the GIS metadata available. Secondly, when selecting the metrics, they must be meaningful to the study purpose.

The following limitations for each metric are noted and supported by McGarigal and Marks (1995, 2005) and Riiters et al. (1995):

Diversity Metrics

This metric may give similar values for landscapes that are very different in other characteristics. Even with a low diversity result, it may not account for rare or

threatened patch types.

Shape Metrics

Based on perimeter-to-area ratios, the rasterisation of patch boundaries will bias edge length (and patch perimeter) upwards.

Core Area Metrics

Does not account for edge-sensitive concerns. Depth of Edge distance must be specified for species of interest, here, humans and GS interaction. This is a complex metric, and its interpretation is confounded by interactions among patch size and patch shape/complexity.

Edge Metrics

This metric is highly sensitive to map resolution and landscape boundary effects. The finer the resolution, the higher the edge length.

Isolation and Proximity Metrics

A landscape with all patches clumped can produce the same mean nearest neighbour distance as one with widely-dispersed pairs of patches. Many metrics are search-radius dependent.

Contagion and Interspersion Metrics

Some metrics describe the 'texture' or heterogeneity of landscape pattern, others describe the likelihood of patches of the same type being adjacent (e.g. Contagion index, Clumpiness index, Interspersion and Juxtaposition index, Effective Mesh Size). These metrics can be very computer-intensive. As a result, FRAGSTATS uses the 4-neighbor rule for calculating these metrics (i.e. diagonal patches are not counted in formulating the adjacency matrix). This can be a limitation.

Importantly, and as discussed, FRAGSTATS metrics highly are correlated. Many metrics contain redundant information and use many redundant metrics – this can confound interpretation. Some FRAGSTATS metrics are inherently redundant because they are alternate ways of representing the same basic information (e.g., mean patch size and patch density). Metrics can also be empirically redundant due to different aspects of a structure being correlated simultaneously for the landscape under investigation (Cushman et al., 2008). FRAGSTATS is applied to many varied landscape configurations, making consistency of interpretation difficulty. Also, FRAGSTATS metrics do not always measure what they are supposed to. Effects of scale on landscape metrics have been summarised by Wu et al. (2002).

Appendix 5 - Survey Questionnaire Preparation and Development

5.1 Preparation of Data Collection

5.1.1 Confidentiality and Anonymity

All respondent data was confidential and anonymous. A statement of confidentiality and anonymity was found within the SQ (See Figure A5.1).

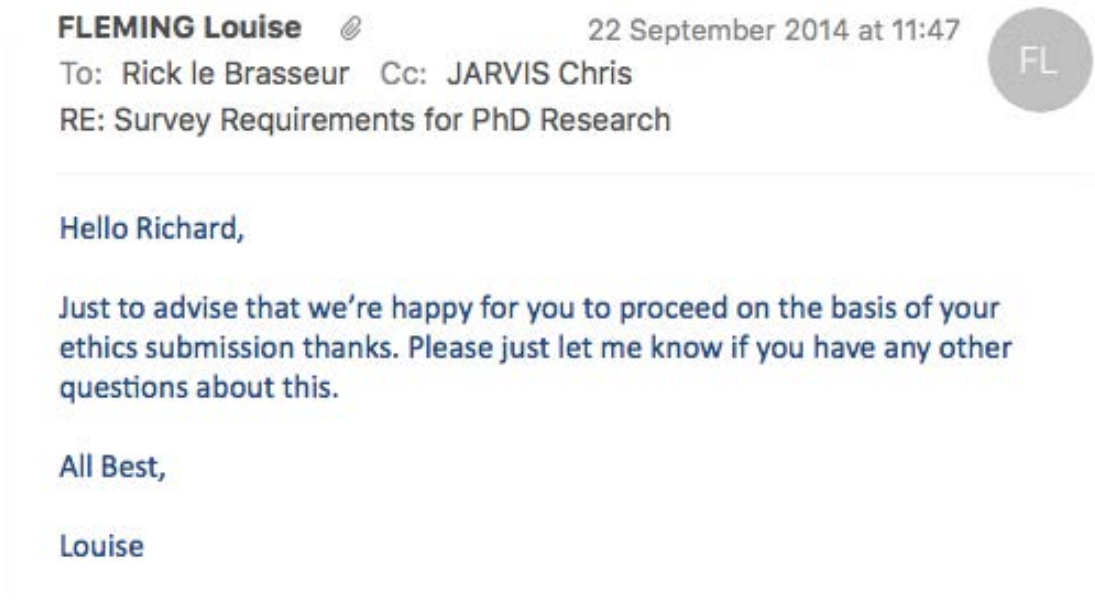
English:
This research study is being undertaken by a PhD Student at the University of Edinburgh. All answers are anonymous. Participation is not required.

Finnish:
Tutkimuksen on toteuttanut Edinburghin yliopiston tohtoriopiskelija. Kaikki vastaukset ovat nimettömiä. Osallistuminen on täysin vapaaehtoista.

Figure A5.1
Statement of Confidentiality
(As found within the Survey Questionnaire)

5.1.2 Ethics

The SQ has fulfilled all Research Ethics Policy and Procedures as required by the University of Edinburgh, Edinburgh College of Art (See Figure A5.2)


FLEMING Louise 22 September 2014 at 11:47
To: Rick le Brasseur Cc: JARVIS Chris
RE: Survey Requirements for PhD Research
FL

Hello Richard,

Just to advise that we're happy for you to proceed on the basis of your ethics submission thanks. Please just let me know if you have any other questions about this.

All Best,

Louise

Ethics and dissemination: Ethical approval has been given by the University of Edinburgh, Edinburgh College of Art Research, Ethics and Knowledge Exchange Committee (ref. 19/06/2012).

Within Survey Questionnaire

English:

Research Policy and Procedures

The survey has fulfilled all Research Ethics Policy and Procedures as required by the University of Edinburgh, Edinburgh College of Art.

Finnish:

Tutkimus Politiikan ja menettelyt

Tutkimus on täyttänyt kaikki Tutkimuseettinen neuvottelukunta toimintaperiaatteet ja menettelytavat edellyttämälläUniversity of Edinburgh , Edinburgh College of Art .

Figure A5.2
Ethical Approval and Statements
(As found within the Survey Questionnaire)

5.1.3 Language and Communication

The primary language of the SQ was English for both sample sets. However, the Finland-based sample also had the option of a complete Finnish language SQ. All information, including ethical approval and statement of confidentiality was provided in both English and Finnish.

5.1.4 Survey Questionnaire Layout and Graphic Depiction

The layout and graphical depiction of the questionnaire was important to provide clarity and legibility, promote survey completion, and reduce respondent fatigue. There were many elements that had to be considered to promote survey completion and data collection.

Font

The following font design and layout was determined most applicable to legibility within the questionnaire's web-based distribution format:

Font	Times New Roman
Font Size	16 font minimum - 32 font maximum (48 font for title screen)
Font Style	Regular, Bold, Italicised and Underline only
Font Colour	Black only
Font Alignment	Left Justified

Imagery

Though imagery is an important tool conveying the concept of green space and green structure to SQ participants, this study did not want to rely on imagery excessively or even moderately as the interpersonal subjective nature of imagery

could impact the response and data collection. This study sought to limit the use of photos, maps, and illustrations and utilise descriptive text to the best degree possible.

In order to reduce any pre-programmed preference for 'green' or 'natural' imagery and the various psychological states they elicit (Ulrich, 1981), a diversity of GS in a variety of states (i.e. early growth vs successional growth; spring vs winter; heavily populated vs sparsely populated) was used.

All imagery for this questionnaire can be found within the CAs; the use of stock-imagery or 'pretty' green spaces was avoided. A study by Hansen (2002) discusses the high use of *"mostly pristine and unspoiled natural environments"* in media and how this over saturation in the public consciousness could have perceptual and behavioural consequences.

Additionally, a variety CA-based GS images were presented, both in scale and in typology, including urban to semi-urban to semi-natural to natural levels of 'greenness'. This study did not want to influence the participant's psychological disposition when answering the questions. For instance, if images of forests and woodlands were predominately shown, this might influence the respondent's selection for those types of GS. If a series of flat, smooth landscapes that mimicked the African-savannah were shown, these could adversely impact a respondent's selection as humans are predisposed to these typologies (Orians, 1980; Kaplan, 2001). It was preferred that the verbal descriptions of GS provided the respondent with a wide variety of potential spaces from which to begin to select their own GS.

The interactive satellite imagery was provided by Bing Maps (2015 Microsoft Corporation).

Colour

No imagery was photo manipulated (i.e. photoshopped) for colour or saturation enhancement. Paisley, Scotland's and Helsinki, Finland's satellite base-map image had differing resolution levels and source, thus in order to achieve the high-contrast required for clear communication, differing colours were utilised in the questionnaire mapping efforts.

Specifically, Paisley, Scotland's SQ had a Purple catchment area outline and utilised Pink and Yellow geomarkers whereas Vantaa, Finland had a Bright Green catchment area outline and Orange and Green geomarkers (See Figure A5.3).

The SQ's Soft-GIS interface allowed the participant to zoom in or out as desired

in order to best locate, for instance, their ‘Home’ location, then drop a ‘pin’ there, thus ensuring data response. Additionally, two base map styles were provided, both were Bing Maps. The default had less text than the second option, and both were noted in the upper right corner of the SQ’s screen (See Figure A5.3).

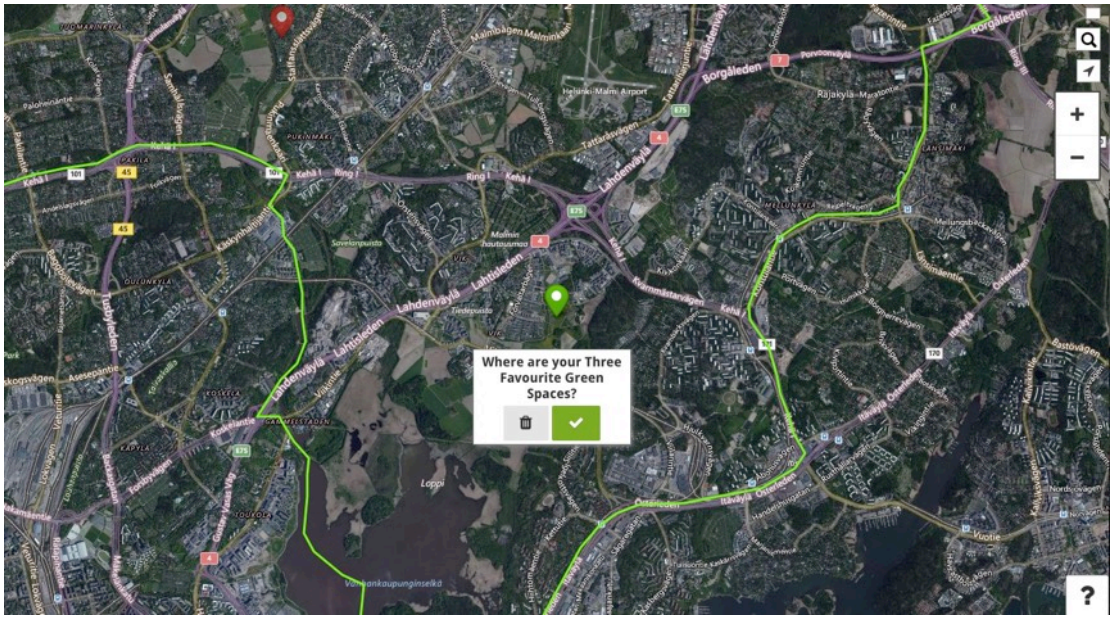


Figure A5.3
SOFT-GIS Screen Format

Language Structure and Description

The language structure of the SQ was clear yet descriptive and non-conflicting. Where required, soft-qualitative descriptors were used which were not vague (e.g. *“The streets are always busy, sometimes busy, never busy”)* and the language was repeatable and engaging (e.g. *“I feel safe when …”).*

The language structure of the SQ was critical to receiving meaningful data. An important component of this SQ was to convey what a GS is within the context of this research in order that the respondents can provide the appropriate information required for analysis. This was achieved through a combination of verbiage and imagery. Descriptive text of these various GS required simple yet clear language with limited subjectivity. If a descriptor was utilised, it was a soft-qualifier (i.e. small). Vague language was removed.

An example of this would be:

- Green corridors such as trails, pathways, canalbanks, cycleways, bridleways, and rights of ways.
- Public spaces such as small fountains or with green vegetation.

• Waterside and harbour areas.

• Green lanes and tree avenues with planting edges.

In addition, a few words referring to the varying regional and cultural contexts of the survey's two CAs were modified. For instance, 'Tram' was added to the Vantaa, Helsinki answer option for modes to visit GS. In the description of various GS, the Paisley, Scotland questionnaire listed 'bowling greens', 'burns and canals', and 'hobby areas' whereas Vantaa, Finland removed these and listed 'ski tracks and skating areas'.

Additionally, in the question's selection of activities, Paisley, Scotland's 'enjoy natural areas' was replaced with 'enjoy the forest' to reflect Finland's cultural activities within their forests.

Significantly, the overall SQ is structured around the concept of Affordances. This required active verbs such as *"recreating, relaxing or socialising"* or sentence structure which conveyed an action such as *"to do"*, *"play with kids"*, *"be with friends"*, and *"visit"*. Any language that suggested concepts of preference (e.g. *"like to do"* or *"would do")* or a green space's implied or indirect use (i.e. perceived affordance) was revised or removed. In summary, the questionnaire's language focusses on what activities or uses the GS provide or furnishes through direct, active, and functional interaction.

Questions

In order to increase the likelihood of survey completion, the SQ had only a small amount of questions within its on-screen, digital delivery method. Specifically, there were a total of 30 maximum possible questions if the participant completed the requested three geomarker locations each for the "Favourite Green Space I Visit" and "Other Green Space I Visit" questions. No minimum questions or screens could be estimated accurately due to the organic nature of the questionnaire's format and ability to move forward on screens without providing data. Though the SQ's format of 30 maximum questions appears to cause concern for drop-out rates as described by Harris (1997) who suggested 15 maximum, of these 30 questions, 10 are repeated or duplicate questions specific to GS markers.

A valuable metric with on-line questionnaires is the number of clicks of a mouse button. This questionnaire had a maximum of 49 clicks. The approximate time for questionnaire completion was 10 minutes. This was stated as the first sentence on the second screen. Other SQ details are noted below:

TOTAL SCREENS	maximum 17 screens
TOTAL QUESTIONS	maximum 30 questions*
TOTAL SCREENS w/ QUESTIONS	9 screens
TOTAL CLICKS	maximum 49 clicks**

** for which a response or action (e.g. click or manual typing) was required*
*** assuming 3 each for Favourite Green Space and Other Green Spaces*

Approximate Survey Time to Completion - 10 minutes (10 - 15 minutes).

5.1.5 Survey Questionnaire Incentive

The incentive chosen was to offer a 50 Euro/Pound gift certificate to three respondents in each sampling area through a random selection upon completion of questionnaire. Local sponsors within the neighbourhood areas to offer incentives or benefits/discounts/certificates, etc. were not appropriated.

5.1.6 Survey Questionnaire Opt-out

There was no opt-out option or button available during the SQ; a respondent could just close the browser window or web page if they wanted to stop. However, respondents could quickly move through the screens without providing input to get to the last screen that required contact information in order to be eligible to receive the VISA Gift Card. During the Gift Card award random selection, participants who did provide their contact information but did not provide a home location or any green space locations were removed from the Gift Card eligibility pool as this was an indicator of questionnaire non-completion.

5.1.7 Survey Questionnaire Review, Pilot Test, and Feedback

After a series of discussions on the SQ's design (i.e construction, measurement, and validity) with Thesis advisors, the questionnaire was incorporated into its final operationalised software, Mapita, in order to receive feedback in its operationalised format. The SQ was then reviewed by two academics at The University of Edinburgh and two professionals within Renfrewshire, Scotland. Minor revisions resulted.

A Pilot Test was conducted with three PhD students at The University of Edinburgh College of Art and were not landscape architecture students. This simulated an actual SQ process from original email to survey completion. No questions could be asked of me or any other participants during this process. A short 10 minute focus group was conducted after the Pilot Test. Comments on content, question construction, data measurement, language, presentation (i.e. design and

layout) and context were received. No post-questionnaire data analysis was completed; this pilot test was reviewing the ease, appropriateness, and efficacy of the digital questionnaire delivery. No significant modifications were made from the Pilot Test feedback.

This final SQ version was slightly modified for the Finnish context and reviewed by Marketta Kytaa, the creator of this study's PPGIS Methodology - SoftGIS, in Helsinki, Finland. Similar comments were received and feedback included specific language to GS typologies. Upon this review, it was translated into Finnish and reviewed by a Finnish PhD student and a Finnish academic for linguistic accuracy and cultural bias. Changes included specific language to GS typologies and common-terms for Finnish 'slang'.

Appendix 6 - Survey Questionnaire Email Distribution

6.1 Introduction

This section discusses the approach to both collecting and distributing email addresses within each catchment area for the on-line SQ followed by a brief review and discussion of this methodology's efficacy in collecting data.

6.2 Survey Questionnaire Email Format

The format of the email messages requesting SQ participation are included below. The Vantaa SQ was translated into Finnish for distribution.

1. Council Members
2. Governmental and Municipal Employees

RE: Community Research Survey Distribution Request

Mr/Mrs:

Good day. I am hoping you can help me.

I am looking for community members to participate in a research study on green spaces and its affect on well-being for a PhD Thesis at the University of Edinburgh.

I have a short 10-15 minute interactive, map-based survey which needs participants for and am hoping you can help spread and forward it to members in your community and other Council members or any other interested parties and groups.

You may have a Facebook page, an e-list of all your members, or a newsletter which you use to communicate with your group. Please forward the following short note at the bottom of this email to your group.

Your assistance in getting this survey out there to community members and residents will help make decisions which support human quality of life and the design and management of the many green spaces within the neighbourhoods and communities around Vantaa and the Helsinki Region/Renfrewshire.

Thank you very much for your time. Please contact me should you have further questions or ideas.

Richard le Brasseur
PhD Candidate, The University of Edinburgh
r.lebrasseur@ed.ac.uk

SHORT NOTE TO BE FORWARDED in your Email
(Please copy and paste as needed)

November 2014

Hello. We are looking for community members to participate in a research study on green spaces and its affect on well-being at the University of Edinburgh.

Your participation will help make decisions which support human quality of life and the design and management of the many green spaces within your neighbourhood and community around Vantaa and the Helsinki Region / Paisley and the Glasgow Region.

Upon completion of the survey, you will be eligible to receive one of three 50 British Pound / URO 50VISA gift cards to be selected at random on November 15, 2014 / January 15, 2015.

PLEASE CLICK TO TAKE SURVEY:

http://maptionnaire.com/en/206/ / http://maptionnaire.com/en/236/

3. Community Groups
November 2014

Good day. We are looking for community members to participate in a research study on green spaces and its affect on well-being for a PhD Thesis at the University of Edinburgh.

We have a short 10-15 minute interactive, map-based survey which we need participants for and am hoping you can help spread and forward it to members in your group and other interested parties.

You may have a Facebook page, an e-list of all your members, or a newsletter which you use to communicate with your group. Please forward the following short note at the bottom of this email to your group.

Your assistance in getting this survey out there to community members and residents will help policy makers and Councils make decisions which support human quality of life and the design and management of the many green spaces within the neighbourhoods and communities around Vantaa / Helsinki Region/Renfrewshire.

Thank you very much for your time. Please contact me should you have further questions or ideas.

Richard le Brasseur
PhD Candidate, The University of Edinburgh
r.lebrasseur@ed.ac.uk

SHORT NOTE TO BE FORWARDED in your Email
(Please copy and paste as needed)

November 2014

Hello. We are looking for community members to participate in a research study on green spaces and its affect on well-being at the University of Edinburgh.

Your participation will help make decisions which support human quality of life and the design and management of the many green spaces within your neighbourhood and community around Vantaa and the Helsinki Region/Paisley and the Glasgow Region.

Upon completion of the survey, you will be eligible to receive one of three EURO 50/50 British Pound VISA gift cards to be selected at random on January 15, 2015.

PLEASE CLICK TO TAKE SURVEY:

http://maptionnaire.com

6.3 Survey Questionnaire Email Distribution Results

Paisley, Scotland Survey Questionnaire	
113	*Total # of email addresses collected*
86	*Total Emails sent to Council Members, Municipal/National Employees, Agency Members, etc. (See #1 and #2 below) (Scotland, E. Renfrewshire, Renfrewshire, Glasgow)*
27	*Total Emails sent to individuals and community groups (See #3 below)*
8	*Emails received stating they have forwarded the information/survey link to others*
Vantaa, Finland Survey Questionnaire	
185	*Total # of email addresses collected*
181	*Total Emails sent to Council Members, Municipal/National Employees, Agency Members, University Groups and Government Funded Agencies, etc.*
4	*Total Emails sent to individuals and community groups*

Table A6.1

Survey Questionnaire Email Distribution Results

6.4 Survey Questionnaire Email Distribution Results Discussion

There is no way of knowing the impact or efficacy of the email distribution of the SQ. This samples added to the final SQ sample via the Direct Email distribution method is unknown. In this regard, any sample is considered not indicative of the population or not random. The samples generated from this methodology, if any, are considered a clustered sampling. The Vantaa email distribution list was significantly larger in the governmental and municipal-based emails. Access to this information was more direct than Paisley and Glasgow's list of potential contacts. Further discussions to sample error and validity occur within the body of this Thesis.

Appendix 7 - Facebook Page Development and Distribution

7.1 Facebook Page Development

Each region had a Facebook community page created. These were entitled “Renfrewshire Green Space and Well Being” (Facebook Page ID 1464863610459367) and “Vantaa and Helsinki Region Green Space and Well Being” (Facebook Page ID 1559661464270944 and Finnish language version 1485815738373565). “Renfrewshire” was utilised within the Facebook page title due to its regional context and familiarity within the targeted community. Two similar Facebook pages for the Vantaa CA were created - one in English and one in Finnish.

This community Facebook page included images from the on-line SQ and a hot-link to the survey itself. In addition, a few short posts utilising the same text within the survey were added to the Facebook page to provide information and encourage participation..

Once the Facebook pages were created, they were strategically shared and posted on other Facebook pages within the Region. These pages included a variety of public and private entities including councils, parks, societies, gyms, community centres, churches and other interest groups. These pages were selected utilising a general search within Facebook and various keywords including, for example, regional nomenclature (Paisley, Renfrewshire, East Renfrewshire, Glasgow) and green structures typologies (Parks, green space, open space, recreation).

Appendix 8 - Survey Questionnaire Data Collection Structure

8.1 Data Collection Procedure

Part 1 – Demographic Data (Individual Factors)

Home Location

The SQ first asks respondents to identify on the map (geo-locate and drop the marker) their Home location.

Participant Age

The desired age for respondents was from 18-75. This range estimates active persons able to utilise green spaces while also being of age to be documented in the demographic and socio-economic data collected. Though the survey initially had an age cutoff of 70 years, it was determined that due to improved medical practices and overall increased physical health in the population, 75 would be the cutoff. Of note, no one over 75 responded to the surveys.

Participant Gender

Standard SQ data required for effective analysis.

Household Dog Ownership

Owning a dog predominately requires an interaction with a GS.

Household Car Ownership

Owning a car allows individuals to travel to specific GS in order to achieve a specific HWB benefit. Though other forms of transportation exist which also provides this, a car is a standard metric for effective analysis.

Socio-Economic Information

The geo-coordinated 'home' marker provided was correlated to their Postal Code which was then correlated to various socio-economic datasets available on-line.

- At Risk of Poverty Threshold Ranking (Per geo-location);
- Depravity Quintile Ranking (Per geo-location);
- Household Income Level (Average per Post Code);
- Education Level (Average per Post Code).

Not Requested Factors

Several individual factors were not solicited within the survey. Though they are interesting variables in themselves and do give a more refined perspective of the GS user, it was determined that the potential of respondent fatigue removed additional questions for data. Additionally, these questions were decided to not provide important information to the study's objective of GS HWB benefits through affordance or interaction. These removed variables include:

Household Size
- *(# of Persons Total)*

Marital status
- *Single*
- *Married*
- *Civil partnership*
- *Cohabiting/Living as married*
- *Divorced/separated*
- *Widowed*

Children in Household under 16
- *Yes*
- *No*

How long have you lived in this Neighbourhood
- *Under 3 years*
- *Between 3 and 7 years*
- *Over 7 years*

Employment Status
- *Full Time*
- *Part Time*
- *Unemployed*
- *Disabled*
- *Prefer not to Answer*

Household Income Level per week
- *under £150*
- *£150 to under £300*
- *£300 to under £500*
- *£500 to under £700*
- *£700 and over*

Home Ownership
- *Yes*
- *No*
- *Council*

Ethnicity or Origin
- *National*
- *Immigrant*

Table A8.1

Survey Questionnaire Social-Based Variables Not Included

Part 2 – GS Interaction

Not Included GS Questions

The following list includes questions other research on GS use and interaction has asked, mostly focused on qualitative aspects of the GS. For similar reasons as stated above, this SQ did not utilise the following though considered:

How would you rate the public transport?
Very convenient
Convenient
Inconvenient

Do the green spaces you visit feel clean, safe, and attractive?

Are your favourite green spaces too far away for you to visit as often as you like? Are they safe to get to?

Do these green spaces allow for interaction and talking with your neighbourhood and friends?

Are there enough and enough different kinds of green spaces near to you?

Would you like more or less green spaces?

What makes this community special for you?

Why do you visit green spaces?

Table A8.2

Survey Questionnaire GS Variables Not Included

Part 3 – Life Satisfaction

Other single question subjective well-being questions were considered (e.g. UK Office of National Statistics (ONS), Andrews and Withey "Delighted-Terrible" scale). Additionally, eudainmonic measures of well-being were deemed too focussed on psychological well-being and mental health.

Appendix 9 - Survey Questionnaire Screen Content

9.1 Paisley, Scotland Survey Questionnaire

Screen 1

Green Space & Well Being Interactive Map Survey
Green spaces are an important part of our everyday life. Whether parks or open spaces, gardens or playgrounds, trails or urban forests, people use green spaces differently for many benefits.

In a recent survey, 91% of the UK population agree that the quality of such green spaces directly affects their quality of life (forestry.gov.uk).

Why do you use the many green spaces in your community? Do you use them to recreate and other leisure activities? Do you go to them to socialise or to be with family and friends? Perhaps you like green spaces for the quietness and ability to relax and clear your mind?

In order to design and manage the best parks, trails, and green space system, we need to know about how you use green spaces - its parks, trails, woodlands, plazas and gardens, rivers and streams, and other open space areas.

The interactive map allows you to share ideas about a specific green space, or even a special, unique place within a green space you visit.

You do not have to live in Renfrewshire or East Renfrewshire to participate - but if you have used the many green spaces in the region, your input is helpful.

By responding to the survey, you can participate in gathering information on these important topics and impact the future of Renfrewshire's and Scotland's green spaces.

Screen 2

Green Space and Well Being
This short, interactive survey should take 10 minutes.

This research study is being undertaken by a PhD Student at the University of Edinburgh. All answers are anonymous. Participation is not required.

Different members of your household can participate. Upon completion of the questionnaire, you will be eligible to receive one of three 50£ VISA gift cards to be selected at random on November 15.

This survey has fulfilled all Research Ethics Policy and Procedures as required by the University of Edinburgh, Edinburgh College of Art. For a full description of this research study, please click **HERE**.

Thank you
If you have any questions, please contact me:.

Richard le Brasseur
PhD Candidate
The University of Edinburgh
Email: r.lebrasseur@ed.ac.uk.

*Hot-link to Research Study (above shown in "**HERE**")*

Green Space and Well Being

October, 2014

This web page provides further information on the Green Space and Well Being interactive mapping survey.

This research study is being undertaken by a PhD Student at the University of Edinburgh. Participation is not required.

Research Policy and Procedures
The survey has fulfilled all Research Ethics Policy and Procedures as required by the University of Edinburgh, Edinburgh College of Art. This survey has been approved by the Edinburgh College of Art Research Directors.

Research Purpose
The goal of this research is to increase the understanding of green spaces and their effects upon human quality of life benefits such as well-being, reduced stress, sociability, sense of community, safety, and happiness.

Your participation will help policy makers and Councils make decisions which support human well being and the design and management of the many green spaces within your neighbourhood and community around Paisley and Glasgow.

What is Human Well Being and Quality of Life?
There are many definitions of both quality of life and well being.

Human well being is connected to one's quality of life. Well-being is understood as a state of health, happiness and prosperity.

As noted by the United Kingdom's Economic and Social Research Council (ESRC): "Well-being is a state of being with others, where human needs are met, where one can act meaningfully to pursue one's goals, and where one enjoys a satisfactory quality of life".

This research will focus on the following 3 types of well being:

Emotional Well Being (happiness, enjoyment, and free from stress)

Physical Well Being (leisure, safety, and relaxing outdoor activities)

Social Well Being (community interaction and support, sense of appreciation)

If you have any questions, please contact me:

Richard le Brasseur
PhD Candidate
The University of Edinburgh
Email: r.lebrasseur@ed.ac.uk

Screen 3

What is Green Space?

This short survey will ask you to mark on a map the locations of green spaces you visit and tell us a little about them.

Green space can be many things. These are spaces you go to for recreation, leisure, socialising, relaxing, enjoying the views and interacting with nature, and walking. These green spaces can be public or private and can be managed or unmanaged.

Some of the most common types of green spaces in Scotland communities include:

- Regional parks or county parks - often with benches, fountains, picnic spaces, toilets and other facilities.
- Outdoor sports facilities such as football pitches, bowling greens, tracks, golf courses.
- Small neighbourhood parks, gardens & other green spaces including private gardens such as your own or lawn area.
- Formal gardens or village greens in housing areas. Decorative plantings.
- Grasslands and Meadows or other countryside and rural spaces.
- Playgrounds and other outdoor children's play and gathering spaces.
- Woodlands, forests and wildlands including tree hedgerows.
- Green corridors such as trails, pathways, canalbanks, cycleways, bridleways, and rights of ways.
- Public spaces such as small fountains or with green vegetation.
- Waterside and harbour areas.
- Green lanes and tree avenues with planting edges.
- Wildlife conservation areas, heritage sites or other nature sites.
- Allotments, community gardens and urban farms.
- Cemeteries, disused churchyards and other burial grounds.
- Civic spaces such as market squares or pedestrian gathering spaces or other community event spaces.
- Farms with Agricultural, Grazing, or Orchards.
- Natural and semi-natural areas. Wild or designed green spaces.
- Blue corridors with waters such as rivers, lakes, reservoirs, wetlands, burns, canals and streams.

Screen 4

Find your Home
Let's locate your Home.

Click on the Red Marker below.

You will then see the Map and you can move the marker or the Map to place it on your home location.

Your home can be anywhere on the map, not just inside the Purple outline.

You can zoom in or out and move around the Map using your mouse and touchpad or the buttons on the Map.

There are two map layers to choose from. Clicking the Paisley Region Boundary box will uncheck this layer and give you more detailed roads and local names to the map image.

Press SAVE to drop the Marker on your home.
Place the Marker on your home (HOT LINK TO MAP – See Screen 5 Below)

Once you have located your Home, a pop-up question will appear.
Click SAVE ANSWERS to finalise your responses.
Click CLOSE to start over.

Once you have located your Home on the Map, click the NEXT button below.

Screen 5 – Pop-Up

An interactive map of the catchment area appears on the screen. The approximate scale of this default map is to show the entire catchment area. The satellite imagery is provided by Bing Maps (2015 Microsoft Corporation).

This default map contains a bright purple outline for the catchment area. Purple was chosen as the color to contrast with the dark green and grays of the satellite imagery map for the Paisleyi Region.

This interface allows the participant to zoom in or out as desired in order to best locate the geomarker for their 'Home' location.

Additionally, two base map styles are provided, both are Bing Maps. The default has less text than the second option, noted as the "Paisley Region Boundary" in the upper right corner of the screen.

After the 'Home' location is geocoded on the map, a pop-up window appears.

Screen 6 - Pop Up

This screen has 4 questions in the window. Each is answered by ticking the corresponding box. Only 1 tick is allowed per question.

What is your age?

- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65-75

What is your Gender?

- Male
- Female

Do you or your family own a Dog?

- Yes
- No

Do you or your family own a Car?

- Yes
- No

Screen 7

Find your Favourite Green Spaces

First, locate your Three Favourite green spaces that you visit in and around Paisley within the Purple Outline Zone shown on the Map.

Click on the Green marker below to see the Map. You can then move either the marker or the map to place it on the green space.

You can zoom in or out and move around the Map using your mouse and touchpad or the buttons on the map.

Where are your Three Favourite Green Spaces? (HOT LINK TO MAP)

Please repeat this for your Three Favourite and special green spaces you visit within Purple Outline Zone on the Map.

Once you have located your Three Favourite green spaces on the Map, click the NEXT button below.

Screen 8 - Pop Up

The same interactive map of the catchment area appears as per Screen 5.

After the first 'Favourite Green Space' location is geocoded on the map, a pop-up window appears. This screen has 4 questions in the window. The first two questions are answered by ticking the corresponding box. Only 1 tick is allowed per question.

What do you most often do in this Favourite Green Space when you visit? Please only pick one.

- Recreate and Play Sports or other Activities
- Be with friends and family, play with kids, or socialise
- Relax, be quiet and enjoy nature

How do you usually get to this Favourite Green Space? Please check all that apply.

- Walk
- Bike
- Car
- Bus
- Train

Are there any specific issues or problems at this Green Space?

_____

Do you have any ideas for improvements to this Green Space?

_____

Screen 9 - Pop Up

Favourite Green Space (per Screen 8)

Participants are requested to provide three (3) Favourite Green Space locations and answers to the questions before proceeding. This screen is Favourite Green Space #2.

Screen 10 - Pop Up

Favourite Green Space (per Screen 8)

Participants are requested to provide three (3) Favourite Green Space locations and answers to the questions before proceeding. This screen is Favourite Green Space #3.

Screen 11

Other Green Spaces you Visit

Great. You are almost done with this survey. Only two more pages.

Please tell us about other parks or green spaces in the Renfrewshire and Paisley area that you visit.

Click on the Pink marker below to see the Map. You can move either the marker of the map to place it on the green space. You can zoom in or out and move around the Map using your mouse and touchpad or the buttons on the map. Press SAVE to drop the Marker on the green spaces you go to.

Green Spaces I Visit (Hot Link to map)

Please repeat this for as many green spaces as you wish for those you visit and enjoy within the Purple Outline Zone on the Map.

Once you have located the green spaces you often visit on the Map, click the NEXT button below.

Screen 12 - Pop Up

The same interactive map of the catchment area appears as per Screen 5 and Screen 8.

This screen has one (1) question in the window. The question is answered by ticking the corresponding box. Here, multiple ticks are allowed.

Other Green Spaces you Visit

What do you typically do at this Green Space when you visit?
Please check all that apply.

- Play sports and games or ride the bike.
- Sit and relax, read, be peaceful and enjoy nature.
- Get together with friends and family, have picnics.
- Walk the dog.
- Bring the kids to play.
- Socialise with others, catch-up or gossip.
- Walk, run, jog or hike.
- View wildlife and special natural areas.
- Garden and Farm.

Participants are requested to provide an unlimited amount of Other Green Space locations and answers to the questions before proceeding. This screen is Other Green Space #1.

Screen 13 - Pop Up

Other Green Spaces you Visit (as per Screen 12)

This screen is Other Green Space #2.

Screen 14 - Pop Up

Other Green Spaces you Visit (as per Screen 12)

This screen is Other Green Space #3.

Screen 15 - Pop Up

Other Green Spaces you Visit (as per Screen 12)

This screen is Other Green Space #4.

Screen 16

Rate your Quality of Life
Last question.

The goal of this research is to increase the understanding of green spaces and their effects upon human quality of life benefits such as well-being, reduced stress, sociability, sense of community, safety, and happiness.

How dissatisfied or satisfied are you with your life overall?
Consider your overall state of health, home life, financial situation, family and friends, leisure activities and work or education circumstances.

I am very satisfied with my current life.
I am satisfied with my current life.
I am neither satisfied nor unsatisfied with my current life.
I am unsatisfied with my current life.
I am very unsatisfied with my current life.

The results will be handled confidentially. No single respondent can be identified.

Screen 17

Thank you
Thank you for completing this important questionnaire. Your input will help city councils and decision makers to better design and manage the various green spaces within the Paisley region.

You are now eligible to 1 of 3 50 British Pounds VISA Gift Cards to be selected at random from all completed participants on November 15.

There will be no way to trace your name provided to the answers in the survey, this is a separate part from the other questions.

Please provide your name :

_____

Your preferred method of contact - Phone Number, Email address, or Royal Mail Address and Postcode:

_____

Thank you for taking the time to provide your input.

Richard le Brasseur
PhD Candidate
The University of Edinburgh
Email: r.lebrasseur@ed.ac.uk

Please email me with any comments or suggestions you may have regarding this research study.

You have reached the end of this survey.

All of your responses have been saved in progress and there is no "Submit" button necessary. Feel free to go back and add more information or edit your responses (you can click on Markers to edit or delete them).

When you are done, just close the web browser or go to a new web page.

You can also share this link with your networks to help us reach even more green space users. Please email or share this survey with your friends in the Paisley region.

http://maptionnaire.com/en/206

9.2 Vantaa, Finland Survey Questionnaire

Screen 1

Green Space & Well Being Interactive Map Survey
Vaihda suomenkieliseen versioon sivun alalaidasta

Green spaces are an important part of our everyday life. Whether parks or natural areas, gardens or playgrounds, forests or paths, people use green spaces differently for many benefits.

In Helsinki, more than 80% of the residents stated the role of green areas in contributing to the quality of their living environment as very important (Tyrväinen et al., 2004).

Why do you use the many green areas in your community? Do you use them to recreate and other leisure activities? Do you go to them to socialise or to be with family and friends? Perhaps you like green spaces for the quietness and ability to relax and clear your mind?

In order to design and manage the best parks, trails, and green space system, we need to know about how you use green spaces - its natural areas, sports areas, woodlands and forests, water edges and rivers, plazas and gardens, and other open land areas.

The interactive map allows you to share ideas about a specific green area, or even a special, unique place within a green space you visit.

By responding to the survey, you can participate in gathering information on these important topics and impact the future of Vantaa's, Helsinki's and Finland's green spaces.

The second line of this page is in finnish: Vaihda suomenkieliseen versioon sivun alalaidasta. This is translated to: Change to the finnish language version by clicking the button at the bottom of the page.

At the bottom of this screen are two small buttons which allow you to change languages from English to Finnish (suomi).

Screen 2

Green Space and Well Being
This short, interactive survey should take 10 minutes.

This research study is being undertaken by a PhD Student at the University of Edinburgh. All answers are anonymous. Participation is not required.

Different members of your household can participate. Upon completion of the questionnaire, you will be eligible to receive one of three 50 EURO gift cards to be selected at random on January 15.

This survey has fulfilled all Research Ethics Policy and Procedures as required by the University of Edinburgh, Edinburgh College of Art. For a full description of this research study, please click **HERE**.

Thank you
If you have any questions, please contact me:.

Richard le Brasseur
PhD Candidate
The University of Edinburgh
Email: r.lebrasseur@ed.ac.uk.

*Hot-link to Research Study (above shown in "**HERE**")*

Green Space and Well Being

October, 2014

This web page provides further information on the Green Space and Well Being interactive mapping survey.

This research study is being undertaken by a PhD Student at the University of Edinburgh. Participation is not required.

Research Policy and Procedures
The survey has fulfilled all Research Ethics Policy and Procedures as required by the University of Edinburgh, Edinburgh College of Art. This survey has been approved by the Edinburgh College of Art Research Directors.

Research Purpose
The goal of this research is to increase the understanding of green spaces and their effects upon human quality of life benefits such as well-being, reduced stress, sociability, sense of community, safety, and happiness.

Your participation will help policy makers and Councils make decisions which support human well being and the design and management of the many green spaces within your neighbourhood and community around Paisley and Glasgow.

What is Human Well Being and Quality of Life?
There are many definitions of both quality of life and well being.

Human well being is connected to one's quality of life. Well-being is understood as a state of health, happiness and prosperity.

As noted by the United Kingdom's Economic and Social Research Council (ESRC): "Well-being is a state of being with others, where human needs are met, where one can act meaningfully to pursue one's goals, and where one enjoys a satisfactory quality of life".

This research will focus on the following 3 types of well being:

Emotional Well Being (happiness, enjoyment, and free from stress)

Physical Well Being (leisure, safety, and relaxing outdoor activities)

Social Well Being (community interaction and support, sense of appreciation)

If you have any questions, please contact me:

Richard le Brasseur
PhD Candidate
The University of Edinburgh
Email: r.lebrasseur@ed.ac.uk

Screen 3

What is Green Space?

This short survey will ask you to mark on a map the locations of green spaces you visit and tell us a little about them.

Green spaces and green areas can be many things. These are spaces you go to for recreation, leisure, socialising, relaxing, pleasant scenery, interacting with nature, and walking or skiing. These green spaces can be public or private and can be managed or unmanaged.

Some of the most common types of green spaces in Finnish communities include:

• National or Regional parks - often with benches, fountains, picnic spaces, toilets and other facilities.
• Outdoor sports facilities such as football pitches, lakes, ski tracks, skating areas or golf courses.
• Forests, recreation forests and other wooded areas.
• Farms and farming fields with Agricultural, Grazing, or Orchards.
• Exercise or hobby areas.
• Small neighbourhood parks, gardens & other green areas including private gardens and lawn areas.
• Reservoirs, lakes, wetlands and rivers or other places with water edges and shorelines.
• Formal gardens, village greens or other green areas within housing blocks.
• Grasslands and Meadows or other rural spaces or open lands.
• Playgrounds and other outdoor children's play and gathering spaces.
• Wildlife conservation areas or reserves, historical sites or other nature sites.
• Waterside environments or harbour areas.
• Agricultural areas, community gardens and urban farms.
• Cemeteries, churchyards and other burial grounds.
• Green corridors such as trails, pathways and cyclepaths.
• Public spaces such as small fountain or with green vegetation or decorative plantings.
• Green lanes or tree avenues with planting edges.
• Civic spaces such as market squares or pedestrian gathering spaces and other community event spaces.
• Natural and semi-natural spaces. Wild or designed green spaces.
• Blue corridors with waters such as rivers, lakes, reservoirs, wetlands and streams.

NOTE: the language of the green spaces here is relevant to cultural nomenclature.

Not Used 1. Other green areas, public or private, with green vegetation. 2. Open spaces - green or partially paved with some green vegetation. 3. Rocky areas such as cliffs, quarries and cliffs. 4. Wasteland/brownfield which has some green vegetation.

Screen 4

Find your Home
Let's locate your Home.

Click on the Red Marker below.

You will then see the Map and you can move the marker or the Map to place it on your home location.

Your home can be anywhere on the map, not just inside the Yellow outline.

You can zoom in or out and move around the Map using your mouse and touchpad or the buttons on the Map.

There are two map layers to choose from. Clicking the Vantaa Region Boundary box will uncheck this layer and give you more detailed roads and local names to the map image.

Press SAVE to drop the Marker on your home.
Place the Marker on your home (HOT LINK TO MAP – See Screen 5 Below)

Once you have located your Home, a pop-up question will appear.
Click SAVE ANSWERS to finalise your responses.
Click CLOSE to start over.

Once you have located your Home on the Map, click the NEXT button below.

Screen 5 – Pop-Up

Home location

This screen requires the participant to zoom in and out and move the map around in order to best drop a pin in their 'Home' location/

After the 'Home' location is geocoded on the map, a pop-up window appears.

Screen 6 - Pop Up

This screen has four questions in the window. Each is answered by ticking the corresponding box. Only one tick is allowed per question.

What is your age?
- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65-75

What is your Gender?
- Male
- Female

Do you or your family own a Dog?
Yes
No

Do you or your family own a Car?
Yes
No

Screen 7

Find your Favourite Green Spaces
First, locate your Three Favourite green spaces that you visit in and around Paisley within the Purple Outline Zone shown on the Map.

Click on the Green marker below to see the Map. You can then move either the marker or the map to place it on the green space.

You can zoom in or out and move around the Map using your mouse and touchpad or the buttons on the map.

Where are your Three Favourite Green Spaces? (HOT LINK TO MAP)

Please repeat this for your Three Favourite and special green spaces you visit within Purple Outline Zone on the Map.

Once you have located your Three Favourite green spaces on the Map, click the NEXT button below.

Screen 8 - Pop Up
The same interactive map of the catchment area appears as per Screen 5.

After the first 'Favourite Green Space' location is geocoded on the map, a pop-up window appears. This screen has 4 questions in the window. The first two questions are answered by ticking the corresponding box. Only 1 tick is allowed per question.

What do you most often do in this Favourite Green Space when you visit? Please only pick one.
Recreate and Play Sports or other Activities
Be with friends and family, play with kids, or socialise
Relax, be quiet and enjoy nature

How do you usually get to this Favourite Green Space? Please check all that apply.
Walk
Bike
Car
Bus
Train
Tram

Are there any specific issues or problems at this Green Space?

_____

Do you have any ideas for improvements to this Green Space?

_____

Screen 9 - Pop Up

Favourite Green Space (as per Screen 8)

This screen is Favourite Green Space #2.

Screen 10 - Pop Up

Favourite Green Space (as per Screen 8)

This screen is Favourite Green Space #3.

Screen 11

Other Green Spaces you Visit

Great. You are almost done with this survey. Only two more pages.

Please tell us about other parks or green spaces in the Vantaa and Helsinki area that you visit.

Click on the Pink marker below to see the Map. You can move either the marker of the map to place it on the green space. You can zoom in or out and move around the Map using your mouse and touchpad or the buttons on the map. Press SAVE to drop the Marker on the green spaces you go to.

Green Spaces I Visit (Hot Link to map)

Please repeat this for as many green spaces as you wish for those you visit and enjoy within the Yellow Outline Zone on the Map.

Once you have located the green spaces you often visit on the Map, click the NEXT button below.

Screen 12 - Pop Up

The same interactive map of the catchment area appears as per Screen 5 and Screen 8.

This screen has one question in the window. The question is answered by ticking the corresponding box. Here, multiple ticks are allowed.

Other Green Spaces you Visit

What do you typically do at this Green Space when you visit?
Please check all that apply.

Play sports and games or ride the bike.
Sit and relax, read, be peaceful and enjoy nature.

Get together with friends and family, have picnics.
Walk the dog.
Bring the kids to play.
Socialise with others, catch-up or gossip.
Walk, run, jog or hike.
View wildlife and enjoy the forest.
Garden and Farm.

Participants are requested to provide an unlimited amount of Other Green Space locations and answers to the questions before proceeding. This screen is Other Green Space #1.

Screen 13 - Pop Up

Other Green Spaces you Visit (as per Screen 12)

This screen is Other Green Space #2.

Screen 14 - Pop Up

Other Green Spaces you Visit (as per Screen 12)

This screen is Other Green Space #3.

Screen 15 - Pop Up

Other Green Spaces you Visit (as per Screen 12)

This screen is Other Green Space #4.

Screen 16

Rate your Quality of Life
Last question.

The goal of this research is to increase the understanding of green spaces and their effects upon human quality of life benefits such as well-being, reduced stress, sociability, sense of community, safety, and happiness.

How dissatisfied or satisfied are you with your life overall?
Consider your overall state of health, home life, financial situation, family and friends, leisure activities and work or education circumstances.

I am very satisfied with my current life.
I am satisfied with my current life.
I am neither satisfied nor unsatisfied with my current life.
I am unsatisfied with my current life.
I am very unsatisfied with my current life.

The results will be handled confidentially. No single respondent can be identified.

Screen 17

Thank you

Thank you for completing this important questionnaire. Your input will help city councils and decision makers to better design and manage the various green spaces within the Vantaa region.

You are now eligible to 1 of 3 50 EURO VISA Gift Cards to be selected at random from all completed participants on January 15.

There will be no way to trace your name provided to the answers in the survey, this is a separate part from the other questions.

Please provide your name :

_____

Your preferred method of contact - Phone Number, Email address, or Royal Mail Address and Postcode:

_____

Thank you for taking the time to provide your input.

Richard le Brasseur
PhD Candidate
The University of Edinburgh
Email: r.lebrasseur@ed.ac.uk

Please email me with any comments or suggestions you may have regarding this research study.

You have reached the end of this survey.

All of your responses have been saved in progress and there is no "Submit" button necessary. Feel free to go back and add more information or edit your responses (you can click on Markers to edit or delete them).

When you are done, just close the web browser or go to a new web page.

You can also share this link with your networks to help us reach even more green space users. Please email or share this survey with your friends in the Paisley region.

http://maptionnaire.com/en/206

Appendix 10 - Survey Questionnaire Completion Statistics

10.1 Introduction

An important methodology of this research was to distribute an on-line survey questionnaire through digital-means or an internet-based approach. Though an overall response percentage is unknown, there are many quantitative metrics that resulted in the on-line SQ completion. This Appendix provides a full tabulation of such results.

Paisley, Scotland Survey Questionnaire Completion Statistics

68 Total # of Individuals who Clicked on "Take Survey"

THIS IS TOTAL # SURVEY VISITORS TO THE WEBSITE'S FIRST PAGE

5 # of Individuals who took survey at Community Centres
7% of Survey Visitors were at Community Centres

58 # of Individuals who Placed Marker on Home
Required 4 Clicks (3 pages + Map Click)
85% of Survey Visitors Placed Home Marker

57 # of Individuals who provided the Demographic information *(Age, Gender)*
85% of Survey Visitors Provided Demographic Info

63 # of Individuals who Ranked their Life Satisfaction *(6 pages plus Click)*
93% of Survey Visitors Ranked their LS

55 # of Individuals who marked at least 1 Favourite or 1 Like to Visit Green Spaces

THIS WAS PRIMARY DATASET
THIS IS TOTAL # RESPONDENTS ***(n=55)***

Favourite Green Spaces - FGS

58 # of Individuals who Placed Marker on 1 Favourite Green Space
(4 pages plus Map Click)

47 With affordances
69% of Survey Visitors gave Favourite Green Space Affordance Information

7 Without affordances
87% of FGS Respondents gave Favourite Green Space Affordance Information

28 # of Individuals who Placed Marker on all 3 Favourite Green Spaces

25 With affordances
37% of Survey Visitors gave Favourite Green Space Affordance Information to 3

3 Without affordances

90% of FGS Respondents gave Favourite Green Space Affordance Information

66 # of Comments on Issues and Improvement for Favourite Green Spaces
(total 124 comment boxes)
54% of comment boxes were completed
27 Comments were "No" or "None"
39 Comments were qualitative (e.g. write-in, See Appendix 23)
41% of those Comments were:
"No Issues" and/or "No Improvements Needed"

123 # of Total Favourite Green Spaces marked *(3 Requested per Respondent)*
Average 2.0 FGS Marked per Respondent
101 Within Case Study Boundary Area
22 Outside Case Study Boundary Area

Other Green Spaces - OGS

78 # of Total Like to Other Green Spaces marked *(No Limit Requested)*
Average 1.3 Like to Visit GS Marked per Respondent
68 Within Case Study Boundary Area
10 Outside Case Study Boundary Area

40 # of Individuals who Placed Marker on 1 Like to Visit Green Space
(5 pages plus Map Click)
59% of Survey Visitors
40 With affordances (100%)
0 Without affordances

12 # of Individuals who Placed Marker on 3 Like to Visit Green Spaces
18% of Overall Survey Visitors
12 With affordances (100%)
30% of the overall Like to Visit GS Marker Respondents
0 Without affordances

Combined Survey Completion

44 # of Individuals who provided Demographic Info, LS Ranking
and at least 1 FGS with Affordances
65% of Survey Visitors

21 with 3 FGS and Affordances
15 with 3 FGS and Affordances and 1 Like to Visit GS and Affordances
15 with 3 FGS and Affordances and 3 Like to Visit GS and Affordances

15 # of Respondents who provided complete Survey
(7 pages, 42 clicks including Map Clicks plus 8 open ended boxes)
22% of the "Take Survey" Clickers
26% of the "Home Marker" Clickers

201 # of Green Spaces Marked *(Favourite and Like to Visit – FGS + OGS)*
169 Within catchment area
32 Outside catchment area

89 # of Unique Green Spaces Marked (*FGS + OGS)*

51 # of Individuals who Provided Contact Information at end of Survey
3 # of Individuals who Contacted me to say “Great Job” or “Important Information”
3 # of individuals who received 50 Pound Visa Gift Card

Vantaa, Finland Survey Questionnaire Completion Statistics

118 Total # of Individuals who Clicked on “Take Survey”

THIS IS TOTAL # SURVEY VISITORS TO THE WEBSITE’S FIRST PAGE

0 # of Individuals who took survey at Community Centres
0% of Survey Visitors were at Community Centres

110 # of Individuals who Placed Marker on Home
Required 4 Clicks (3 pages + Map Click)
93% of Survey Visitors Placed Home Marker

108 # of Individuals who provided the Demographic information *(Age, Gender)*
90% of Survey Visitors Provided Demographic Info

73 # of Individuals who Ranked their Life Satisfaction *(6 pages plus Click)*
67% of Survey Visitors Ranked their LS

62 # of Individuals who marked at least 1 Favourite or 1 Like to Visit Green Spaces

THIS WAS PRIMARY DATASET
THIS IS TOTAL # RESPONDENTS ***(n=62)***

Favourite Green Spaces - FGS

64 # of Individuals who Placed Marker on 1 Favourite Green Space
(4 pages plus Map Click)

62 With affordances
53% of Survey Visitors gave Favourite Green Space Affordance Information
2 Without affordances

51 # of Individuals who Placed Marker on all 3 Favourite Green Spaces
51 With affordances
45% of Survey Visitors gave Favourite Green Space Affordance Information to 3
0 Without affordances

184 # of Total Favourite Green Spaces marked *(3 Requested per Respondent)*
Average 3.0 FGS Marked per Respondent
148 Within Case Study Boundary Area
36 Outside Case Study Boundary Area

55 # of Comments on Issues and Improvement for Favourite Green Spaces
(total 124 comment boxes)
44% of comment boxes were completed
6 Comments were “No” or “None”

49 Comments were qualitative (See Appendix 23)

Other Green Spaces - OGS

50 # of Individuals who Placed Marker on 1 Like to Visit Green Space
(5 pages plus Map Click)
42% of Survey Visitors
46 With affordances
4 Without affordances

40 # of Individuals who Placed Marker on 3 or more Like to Visit Green Spaces
34% of Overall Survey Visitors
38 With affordances
36% of the overall Like to Visit GS Marker Respondents
2 Without affordances

230 # of Total Like to Visit Other Green Spaces marked *(No Limit Requested)*
Average 3.7 Like to Visit GS Marked per Respondent
89 Within Case Study Boundary Area
13 Outside Case Study Boundary Area

Combined Survey Completion

62 # of Individuals who provided Demographic Info, LS Ranking
and at least 1 FGS with Affordances
53% of Survey Visitors

51 with 3 FGS and Affordances
38 with 3 FGS and Affordances and 1 Like to Visit GS and Affordances
48 with 3 FGS and Affordances and 3 Like to Visit GS and Affordances

48 # of Respondents who provided complete Survey
(7 pages, 42 clicks including Map Clicks plus 8 open ended boxes)
48% of the "Take Survey" Clickers
49% of the "Home Marker" Clickers

247 # of Green Spaces Marked *(Favourite and Like to Visit – FGS + OGS)*
214 Within catchment area
33 Outside catchment area

121 # of Unique Green Spaces Marked (*FGS + OGS)*

42 # of Individuals who Provided Contact Information at end of Survey
0 # of Individuals who Contacted me to say "Great Job" or "Important Information"
3 # of individuals who received 50 EuroVisa Gift Card

NOTES:
No submit button within the on-line SQ, so all data is recorded once placed, regardless of completeness, though 'Back' buttons did exist to allow revisions.

10.2 Survey Questionnaire Completion Statistics Summary

Overall, almost twice as many individuals visited the first page of the on-line SQ in the Vantaa CA (n=118) than Paisley (n=68) suggesting the distribution of the SQ was more effective in the Vantaa CA. Following this trend, Vantaa SQ respondents provided 46 more (17%) individual GS markers than Paisley. In opposition to this trend, however, was the actual number of effective samples between the two CAs (Paisley = 55, Vantaa=62). Interestingly, the number of unique GS identified was larger in Vantaa (n=121) compared to Paisley (n=89). This does not indicate greater diversity in GS visitation overall, however, since the average GS marker location for Vantaa respondents was greater in respect to both the FGS and OGS by almost 1.1 marker per respondent compared to Paisley. Furthermore, although the Vantaa CA's green space and green structure geographic size was over 30,000,000 sq/m larger than Paisley, the number of individual GS patches was less in Vantaa, thereby reducing possible GS marker locations.

The effective sample sizes between the two CAs were quite similar, with Vantaa having only seven more than Paisley. The number of effective GS markers to analyse were 17% higher (n=+46) in the Vantaa CA. Within the Paisley CA effective sample (n=55), for which various data could be analysed, only 15 respondents in the Paisley CA provided the complete survey information (i.e. home location, demographic information, three FGS, three OGS and LS ranking). Although efforts were made to reduce respondent fatigue, this 22% completion result indicates that the SQ may have been too complicated, too cumbersome or uninteresting. In the Vantaa CA overall sample (n=62), the completion rate increased to 77% (n=48). This result suggests Vantaa respondents are more interested in their GS and future planning policy as stated in the beginning of the SQ, or have more time and/or resources to complete SQ's, but these assumptions are unable to be confirmed. Another metric of 'survey completeness' is the total number of GS markers; the results for which are listed below:

CA	Home marker	FGS Marker	OGS Marker
		Per Respondent (Avg)	
Paisley SQ	58	2.0	1.3
Vantaa SQ	110	3.0	3.7

This simple comparison illustrates clearly that Vantaa SQ respondents were more inclined to finish the SQ once started. These discrepancies between samples may be accounted for through varied reasons such as lack of effective distribution, cultural predispositions, lack of internet access, cultural and language barriers, and many other individual and socio-economic factors.

SQ Respondent Accessibility

Only 5 (7%) of the completed Paisley SQ's were completed at the publicly-accessible community centres where internet access and computers were made available. This result suggests that more Paisley SQ's would have been completed if additional facilities and times were provided, but this cannot be confirmed. None (0) of the Vantaa SQ's were completed through similar means.

Appendix 11 - Survey Questionnaire Result Metadata

Paisley, Scotland Survey Questionnaire Results (.csv Format)

27;2014-10-04T09:56:07.553000+00:00;en;1280;;;;;;;;
35;2014-10-04T22:05:49.640000+00:00;en;1024;;0;1;0;0;0;;
36;2014-10-05T12:08:15.988000+00:00;en;1600;;0;1;0;0;0;Grace McCarthy;07889 005049
41;2014-10-05T19:07:47.540000+00:00;en;1920;;0;1;0;0;0;Brian McGuire;brian@paisley.org.uk
45;2014-10-06T08:36:37.505000+00:00;en;776;;0;1;0;0;0;Kate Cuthbert;katecuthbert23@live.co.uk
53;2014-10-06T10:44:38.979000+00:00;en;1280;;0;1;0;0;0;Paul Landman;plandman@cqm.co.uk
58;2014-10-06T10:11:28.281000+00:00;en;1600;;0;1;0;0;0;Ewan McGill;ewanmcgill@hotmail.com
59;2014-10-06T10:23:45.770000+00:00;en;1044;;1;0;0;0;0;Secretary ICC;07599299770
60;2014-10-06T10:13:31.011000+00:00;en;1159;;1;1;0;0;0;Bill Whyte;Email: whwhyte@btinternet.com
61;2014-10-06T10:38:25.352000+00:00;en;1920;;0;1;0;0;0;Valerie Reilly;valerie.reilly@btinternet.com
64;2014-10-06T12:23:18.917000+00:00;en;1440;;1;0;0;0;0;Karen Gilligan ;07909 813293
65;2014-10-06T18:47:17.725000+00:00;en;1664;;1;0;0;0;0;Joe Hill;email
110;2014-10-07T22:17:43.684000+00:00;en;320;;1;0;0;0;0;Scott Forsyth;scott_forsyth@live.co.uk 07868158402
117;2014-10-08T07:56:17.358000+00:00;en;2303;;1;0;0;0;0;John Wilby;07710782510 john.wilby@btinternet.com
121;2014-10-08T09:30:59.917000+00:00;en;1280;;0;1;0;0;0;Gail Burton;gailburton1967@gmail.com
124;2014-10-08T13:31:21.341000+00:00;en;1280;;0;0;0;0;1;Anne Ironside;anne.ironside@gmail.com
128;2014-10-08T14:56:33.229000+00:00;en;1366;;0;0;1;0;0;Jane Ironside;email - jane.ironside@gmail.com
130;2008-01-05T20:30:49.877000+00:00;en;1093;;0;0;0;1;0;donna foote;email donnafoote21@yahoo.co.uk
137;2014-10-09T20:56:10.579000+00:00;en;1280;;0;1;0;0;0;;
180;2014-10-13T14:13:00.667000+00:00;en;1037;;0;0;0;1;0;Chris Gould;chris@ic202.fsnet.co.uk
190;2014-10-13T14:24:59.701000+00:00;en;320;;1;0;0;0;0;Nick Wright;nwplanning@gmail.com
194;2014-10-13T14:56:57.247000+00:00;en;1280;;0;0;0;1;0;;
233;2014-10-13T14:50:08.366000+00:00;en;1533;;;;;;;;
324;2014-10-13T21:24:00.208000+00:00;en;1824;;0;1;0;0;0;Winston Roberts;winston_roberts@hotmail.co.uk
334;2014-10-14T08:22:53.776000+00:00;en;1280;;1;0;0;0;0;Rachel Lawson;lawson.rachel@gmail.com
337;2014-10-14T09:22:09.200000+00:00;en;1365;;0;0;1;0;0;Gail Lyall;thelyall@yahoo.co.uk 07931 965 633
338;2014-10-14T09:31:07.340000+00:00;en;1280;;0;1;0;0;0;Jekaterina Samsonova;jekaterina1003@gmail.com
346;2014-10-14T11:38:55.253000+00:00;en;768;;1;0;0;0;0;James Friend;jfriend@ifb.co.uk
364;2014-10-15T01:46:32.457000+00:00;en;1304;;0;0;0;0;1;;
368;2014-10-15T09:21:40.761000+00:00;en;1366;;1;0;0;0;0;;
369;2014-10-15T10:52:30.494000+00:00;en;1280;;;;;;;;
388;2014-10-16T14:26:33.710000+00:00;en;1195;;1;0;0;0;0;Ruby McKeown;ruby.mckeown@gcvgreennetwork.gov.uk
399;2014-10-17T11:55:07.518000+00:00;en;360;;0;1;0;0;0;Tony Buchanan;
420;2014-10-18T15:06:36.390000+00:00;en;1366;;1;0;0;0;0;Suzanne Ballantyne;s.keizers@ntlworld.com
431;2014-10-20T09:50:27.332000+00:00;en;1024;;0;1;0;0;0;Russell Jones;russell.jones@drs.glasgow.gov.uk
433;2014-10-20T10:09:45.936000+00:00;en;1024;;0;1;0;0;0;Gregor Yates;gregoryates84@gmail.com
434;2014-10-20T11:16:06.099000+00:00;en;1538;;1;0;0;0;0;Mark Shephard;mark.shephard@strath.ac.uk
464;2014-10-20T16:34:42.096000+00:00;en;1366;;0;1;0;0;0;steven mcfarlane;steven.mcfarlane@btinternet.com
493;2014-10-21T09:40:54.955000+00:00;en;1366;;1;0;0;0;0;M J Patrick;mjpatrick@hotmail.com
515;2014-10-22T09:32:07.627000+00:00;en;1280;;1;0;0;0;0;Max Hislop;max.hislop@gcvgreennetwork.gov.uk
523;2014-10-24T10:30:46.218000+00:00;en;784;;1;0;0;0;0;Joanna Glacken;07793492503
530;2014-10-25T21:42:51.427000+00:00;en;768;;0;1;0;0;0;Lesley Sharkey;186 Mains Drive

536;2014-10-28T02:42:37.213000+00:00;en;1366;;0;0;0;1;0;Catherine Gillies;hipster01cg@hotmail.com
561;2014-10-28T11:25:12.078000+00:00;en;418;;0;0;0;1;0;Steve Edwards;steveedwards56@hotmail.com
567;2014-10-28T12:31:57.574000+00:00;en;2303;;0;1;0;0;0;John Wilby;john.wilby@btinternet.com
570;2014-10-28T13:31:19.470000+00:00;en;1040;;0;1;0;0;0;April Shaw;ashaw419(quotation)gmail.com
581;2014-10-28T13:30:17.205000+00:00;en;1366;;1;0;0;0;0;patrick kelly;patk_22@hotmail.com
582;2014-10-28T13:34:28.818000+00:00;en;1280;;0;1;0;0;0;Ewan Kane;Ewan.Kane@renfrewshire.gov.uk
584;2014-10-28T13:30:53.931000+00:00;en;1415;;1;0;0;0;0;;
588;2014-10-28T14:15:54.583000+00:00;en;1920;;0;0;1;0;0;;
617;2014-10-29T09:15:26.309000+00:00;en;;;;;;;;;
641;2014-10-29T14:14:12.170000+00:00;en;776;;0;1;0;0;0;;
658;2014-10-29T20:56:45.954000+00:00;en;1024;;0;1;0;0;0;;
659;2014-10-29T21:10:41.179000+00:00;en;768;;0;0;1;0;0;Ian williams;ianduke01@hotmail.com
669;2014-10-30T14:37:21.282000+00:00;en;978;;0;0;1;0;0;Paul Kaszubski;paul.kaszubski@hotmail.com
670;2014-10-30T16:23:08.388000+00:00;en;1280;;0;0;0;1;0;carol wilson;balasmum@gmail.com
671;2014-10-30T17:49:27.424000+00:00;en;1024;;0;1;0;0;0;David Walsh;davidw_home@btopenworld.com
674;2014-10-31T15:04:52.254000+00:00;en;1920;;0;1;0;0;0;Sarah O'Sullivan;07986 798 098
690;2014-11-01T21:29:54.234000+00:00;en;1024;;0;1;0;0;0;Irene McDonald;irenemcdonald174@orange.net
710;2014-11-02T16:17:44.354000+00:00;en;1199;;1;0;0;0;0;Aileen Wilson;aileen.wilson@strath.ac.uk
754;2014-11-12T15:33:32.688000+00:00;en;1600;;0;1;0;0;0;Ed Lindsay;ed.lindsay01@gmail.com
755;2014-11-12T16:17:42.096000+00:00;en;768;;1;0;0;0;0;;
756;2014-11-12T16:44:18.128000+00:00;en;320;;1;0;0;0;0;Colin Moulson;Colin_moulson@hotmail.com

Vantaa, Finland Survey Questionnaire Results (.csv Format)

55;2014-11-24T11:41:56.605000+00:00;fi;1351;Satu Heikinheimo;0407587805 heikinheimo.satu@gmail.com
56;2014-11-24T11:37:20.289000+00:00;en;1920;;;;0;1;0;0;0
57;2014-11-24T12:00:35.533000+00:00;en;1920;Hang Dao;email: hangbelu@gmail.com Rasinkatu 20A
71;2014-11-28T22:54:02.032000+00:00;fi;1600;Timo HŠmŠlŠinen;sŠhkšposti - 040 51 00 313
73;2014-11-28T17:59:40.258000+00:00;fi;1920;Juha-Matti Tapio;jmtapio@verkkotelakka.net;;0;0;1;0;0
76;2014-11-28T19:08:11.315000+00:00;fi;1076;Olga Hagstršm;olga.hagstrom@helsinki.fi;;0;1;0;0;0
77;2014-11-28T18:05:50.955000+00:00;fi;1920;;;;1;0;0;0;0
82;2014-11-28T19:25:04.721000+00:00;fi;1024;Kai KeinŠnen;Kai.keinanen@gmail.com;;1;0;0;0;0
87;2014-11-28T19:42:44.045000+00:00;fi;1280;;;;0;1;0;0;0
89;2014-11-28T19:55:13.231000+00:00;fi;1228;Harri Myllyniemi;harri.myllyniemi@gmail.com;;0;0;1;0;0
95;2014-11-28T22:39:14.887000+00:00;fi;1366;Matti Kohonen;matti.kohonen@gmail.com;;0;1;0;0;0
102;2014-11-29T08:59:50.888000+00:00;fi;1920;Minna Kontkanen;minna.kontkanen@gmail.com;;0;1;0;0;0
103;2014-11-29T08:42:42.286000+00:00;fi;360;;;;1;0;0;0;0
134;2014-11-29T09:16:44.925000+00:00;en;1366;Becky Hastings;inspectorbeckster@gmail.com;;1;0;0;0;0
136;2014-11-30T17:43:54.406000+00:00;fi;1288;Tuomas Lehtonen;tuomleh@gmail.com;;0;1;0;0;0
140;2014-11-29T09:35:29.528000+00:00;fi;1276;;;;0;0;1;0;0
145;2014-11-29T10:02:17.656000+00:00;fi;1269;Leena Wickman;leena.wickman@gmail.com;;0;1;0;0;0
146;2014-11-29T09:59:28.219000+00:00;fi;1024;Eija Lahdensuo;eijala@gmail.com;;0;1;0;0;0
158;2014-11-29T10:55:20.345000+00:00;fi;320;Lauri Kiukas;laurikiukas@gmail.com;;0;1;0;0;0
160;2014-11-29T11:32:34.281000+00:00;fi;320;Hanna Dhalmann ;Hanna.Dhalmann@ara.fi;;0;1;0;0;0
161;2014-11-29T12:02:01.609000+00:00;fi;1920;Tommi Hautala;tommi.hautala@helsinki.fi;;0;1;0;0;0
162;2014-11-29T13:39:10.738000+00:00;fi;1375;Juuso Rusanen;juuso.rusanen@helsinki.fi;;0;1;0;0;0

164;2014-11-29T13:08:33.763000+00:00;fi;1536;Juhana Harju;sŠhkšposti shantigiriorama@gmail.com;;0;0;0;1;0
173;2014-11-29T16:44:42.738000+00:00;fi;1600;Pia HeinŠnen;linnunlaulumaa@hotmail.com;;0;1;0;0;0
177;2014-11-29T19:56:01.712000+00:00;fi;1600;;;;1;0;0;0;0
180;2014-11-29T20:27:50.760000+00:00;fi;1600;Tapio Linna;tapio.linna@gmail.com;;0;0;0;1;0
183;2014-11-29T20:44:58.258000+00:00;fi;1920;Lea Ulmanen;;;0;1;0;0;0
185;2014-11-29T21:19:46.874000+00:00;fi;1366;J P Roos;jiipee.roos@gmail.com;;0;1;0;0;0
196;2014-11-30T08:17:11.020000+00:00;fi;600;ulla Roine;Karhuniitynyie 12
198;2014-11-30T07:19:50.465000+00:00;fi;1366;;;;1;0;0;0;0
230;2014-11-30T16:34:51.823000+00:00;fi;1277;Rami Rahtu;rami.rahtu@kolumbus.fi;;0;0;1;0;0
244;2014-12-01T08:32:33.616000+00:00;fi;1920;Juha MŠkinen;SŠhkšposti: mcinen@iki.fi;;0;0;1;0;0
252;2014-12-01T14:48:38.936000+00:00;fi;360;Juha Lindy;Alakartanontie 4A32 02360 Espoo;;1;0;0;0;0
258;2014-12-01T19:20:17.223000+00:00;fi;1600;;;;1;0;0;0;0
269;2014-12-02T07:46:42.314000+00:00;fi;1920;Juha Salonen;juha.salonen@skes.fi;;1;0;0;0;0
283;2014-12-02T11:34:19.004000+00:00;fi;320;Mane@iki.fi;Mane@iki.fi;;1;0;0;0;0
284;2014-12-02T11:43:56.255000+00:00;fi;320;Eeva Kuuluvainen;eeva.kuuluvainen@kolumbus.fi;;1;0;0;0;0
297;2014-12-02T15:39:59.921000+00:00;fi;1920;Hannu Kokko;hannu.kokko@aatsto.inet.fi;;0;1;0;0;0
298;2014-12-02T16:16:39.610000+00:00;fi;1920;;;;0;1;0;0;0
304;2014-12-02T17:36:56.427000+00:00;fi;1636;Anna-Maija Tikkanen;ami@geography.hu 040 7171 622;;0;1;0;0;0
308;2014-12-02T18:56:36.671000+00:00;fi;1024;;;;1;0;0;0;0
311;2014-12-02T19:21:34.860000+00:00;fi;1600;Heidi Nurminen;aroheid@yahoo.co.uk;;0;1;0;0;0
317;2014-12-02T20:35:02.746000+00:00;fi;1536;Jyri Mikkola;0400-372433;;0;0;1;0;0
326;2014-12-03T06:28:04.976000+00:00;fi;1309;;;;0;1;0;0;0
328;2014-12-03T06:56:43.333000+00:00;fi;1024;Jonna Sojakka;jonna_sojakka@hotmail.;;0;1;0;0;0
332;2014-12-03T07:48:33.642000+00:00;fi;1680;Seija Bergman;seija.bergman@orion.fi 050 966 2858;;1;0;0;0;0
333;2014-12-03T08:09:23.240000+00:00;fi;1260;;;;0;1;0;0;0
337;2014-12-03T08:49:51.872000+00:00;fi;1280;Mei Lindholm;mei.lindholm@nbl.fi;;0;0;1;0;0
338;2014-12-03T08:55:55.021000+00:00;fi;1366;Maija Karala;maija.karala@gmail.com;;1;0;0;0;0
339;2014-12-03T09:33:15.583000+00:00;fi;1920;;;;1;0;0;0;0
341;2014-12-03T11:02:57.878000+00:00;fi;1436;Sami Haapanala;sami.haapanala@suvilumi.fi;;0;0;1;0;0
342;2014-12-03T11:16:45.504000+00:00;fi;1280;;;;1;0;0;0;0
343;2014-12-03T13:17:13.163000+00:00;fi;1440;;;;0;1;0;0;0
350;2014-12-03T20:23:18.128000+00:00;fi;360;Petra Iwaola;050-4128845;;0;0;0;0;1
358;2014-12-04T12:47:57.106000+00:00;fi;1064;;;;1;0;0;0;0
362;2014-12-04T14:07:42.779000+00:00;fi;1536;sghgh sghgfh;sdthsgfhh;;0;0;1;0;0
367;2014-12-05T09:40:51.345000+00:00;fi;1437;;;;0;1;0;0;0
370;2014-12-05T11:36:44.844000+00:00;fi;1180;Timo Halme;halme.timo@kolumbus.fi;;0;1;0;0;0
374;2014-12-05T16:19:53.577000+00:00;fi;1024;;;;0;1;0;0;0
382;2014-12-08T13:59:55.916000+00:00;fi;1920;;;;0;1;0;0;0
384;2014-12-09T11:26:40.038000+00:00;fi;1920;Tapio Leskinen;tapio.leskinen777@gmail.com;;0;0;0;1;0
398;2014-12-12T11:43:36.255000+00:00;fi;1443;Kari Sundvall;044 522 7115;;0;1;0;0;0
401;2014-12-12T23:17:53.325000+00:00;fi;1150;;;;0;1;0;0;0
402;2014-12-13T08:53:12.882000+00:00;fi;1409;Maria ;maria.lahdenpera@gmail.com;;0;1;0;0;0
431;2014-12-19T13:27:59.534000+00:00;fi;1344;;;;0;1;0;0;0
439;2014-12-21T06:24:47.003000+00:00;fi;320;;;;0;1;0;0;0
441;2014-12-21T08:21:44.350000+00:00;fi;1371;;;;1;0;0;0;0
450;2014-12-27T23:03:29.032000+00:00;fi;1217;Marika PylkkŠnen;marikakp2@gmail.com;;0;0;0;1;0

455;2014-12-30T11:20:36.011000+00:00;en;1920;Silja Mentula;silja.mentula@thl.fi;;1;0;0;0;0

459;2014-12-30T20:02:21.841000+00:00;fi;1280;;;;1;0;0;0;0

467;2015-01-04T19:49:22.657000+00:00;fi;1366;Vilma MetsŠrinne;050 9376412;;1;0;0;0;0

484;2015-01-14T23:20:06.759000+00:00;fi;360;Kaisa Haavisto;Annakaisa.haavisto@gmail.com;;0;1;0;0;0

Appendix 12 - Survey Questionnaire Write-in Responses

Paisley, Scotland Write-in Responses

Question 1 - Are there any specific issues or problems at this Green Space?
no
lack of parking
dog dirt
unsafe at night
Parking at the weekend
Too many coniferous woodland blocks
locked outwith hours
lack of maintenance of footpath network
dogs of lead
dog mess
lack of maintenance
too many dogs
decline in maintenance
antisocial behaviour
car conflict with bicycles
can feel very isolated
lack of maintenance
conflict of dog walkers
litter
neglected
alcohol drinkers
neglected and needs upgrading
litter on hot days
difficult access on busy days
litter and vandalism
no
like the swimming pools
none at all
trash
more wildlife information posts
improved catering
no
maintained well
needs more activities
no
cycle path can be quite busy
no toilets
occasional antisocial behaviour
rubbish after holidays
could be better signposted
littering
no
no
poor maintenance
no

difficult to cycle safely on weekends
poor maintenance
heavy traffic around it

Question 2 - Do you have any ideas for improvements to this Green Space?
no
no
more chairs
needs more benches
more allotments
resurface path
no
allocate some budget
more regular bin collection
start clubs - cycling, fishing
split cycle path with line
no
better tourist information
wardens
public gym
no
no
no
visitor centre or cafe
swimming
no
more bins
no
more bins
no
frequent clean ups
better dog enclosure
plant more deciduous trees - better for wildlife
open to wider community
more cycle lanes - segregated cycle lanes
make the perimetre into a quad bike/cycle track
more facilities

Vantaa, Finland Write-in Responses

Note: These open-ended GS questions were translated by the same translator responsible for the questionnaire translation.

Question 1 - Are there any specific issues or problems at this Green Space?
nice jogging terrain
skiing
nothing happens
too many people
the area may not exactly be a green area

within walking distance
very close
need a boat to get there
noise
snow maintenance
odour problems
improvement of the Vantaa River water quality and increasing the fish stock
improvement of paths and signposts
noise
cut down too many trees
dog conflict
no
play with children
the condition of the path network is poor
road noise and cars makes it not safe for child
garbage
no
no
peace and quite are gone, too loud
alien plant species

Question 2 - Do you have any ideas for improvements to this Green Space?
no
more seating
football field turf could be better.
more plantings
improved maintenance
more walking tacks
better signs
no
in winter, plow skiing track
refreshment stand
canoes for rent
tree maintenance
no
more seating possibilities
noise
speed limit decrease
more parking
noise
not enough garbage cans
larger bins
uutside the gym would be nice
free rowing boats
more benches

Appendix 13 - Survey Questionnaire Results Post-hoc Data Adjustments

13.1 Introduction

A series of post-data collection adjustments were made to the SQ datasets to ensure consistent and valid analysis. This 'cleaning-up' of the data included removing incomplete data, respondents, and markers from the dataset. These are noted below. Incomplete SQ responses and response sets were deleted from further analysis.

GS markers outside of the CA 10km extension were removed (e.g. Cathkin Braes Country Park in the Paisley CA). Other GS markers required removal from analysis: for example, a few markers were found within the active airports of each CA, these are noted as inaccessible and prohibited areas and were removed from analysis.

Paisley, Scotland Survey Questionnaire Dataset

Home Marker

90 People placed a home location on the map

9 were duplicates
81 unique home locations

Respondent data was removed due to incompleteness if the following occurred:
No LIFE SATISFACTION provided
No Green Spaces (FGS and OGS) were provided
No Demographic Info (Sex, Age) were provided

In addition, the following respondent data was removed due to incompleteness:

3 Completed surveys included home locations outside of both Catchment Area, the 3 councils, and outside of Glasgow Metropolitan region

9 Initiated surveys where only got as far as marking home but no demographic data

8 Initiated surveys, demographic data given, but no affordance data for green spaces marked

Sample Size

55 total respondents with minimum criteria met (n=55). This is 61% of people who marked HOME were suitable for analysis.

FGS Markers

162 Individual FGS Markers placed

5 Provided more than 4 markers

7 FGS markers removed

FGS markers were removed if the following occurred:
No AFFORDANCE was noted
No Demographic Info (Sex, Age) were provided

FGS1 n=51
FGS2 n=36
FGS3 n=23
FGS4 n=3
FGS Total n = 113

113 total FGS markers (n=113) provided with appropriate data/minimum criteria met. This is 62% of people who marked FGS were suitable for analysis

OGS Markers
112 Individual OGS Markers placed

6 Provided more than 4 markers
17 OGS markers removed

OGS markers were removed if the following occurred:
No AFFORDANCE was noted
No Demographic Info (Sex, Age) were provided

OGS1 n=35
OGS2 n=18
OGS3 n=11
OGS4 n=5
OGS TOTAL n=69

69 total OGS markers (n=69) provided with appropriate data/minimum criteria met. This is 62% of people who marked OGS were suitable for analysis

Total GS Markers
A total of 182 Individual GS Markers (n=182) were placed and suitable for analysis.

Vantaa, Finland Survey Questionnaire Dataset

Home Marker
110 People placed a home location on the map

3 were duplicates
107 unique home locations

Respondent data was removed due to incompleteness if the following occurred:
No LIFE SATISFACTION provided
No Green Spaces (FGS and OGS) were provided
No Demographic Info (Sex, Age) were provided

Sample Size
62 total respondents with minimum criteria met (n=62). This is 57% of people who marked HOME were suitable for analysis.

FGS Markers
184 Individual FGS Markers placed

3 Provided more than 3 markers
5 FGS markers removed

FGS markers were removed if the following occurred:
No AFFORDANCE was noted
No Demographic Info (Sex, Age) were provided

FGS1 n=62
FGS2 n=48
FGS3 n=35
TOTAL FGS n=145

145 total FGS markers (n=145) provided with appropriate data/minimum criteria met. This is 79% of people who marked FGS were suitable for analysis

OGS Markers
230 Individual OGS Markers placed

18 Provided more than 4 markers
81 OGS markers removed

OGS markers were removed if the following occurred:
No AFFORDANCE was noted
No Demographic Info (Sex, Age) were provided

OGS1 n=47
OGS2 n=30
OGS3 n=17
OGS4 n=8
TOTAL OGS n=102

102 total OGS markers (n=102) provided with appropriate data/minimum criteria met. This is 44% of people who marked OGS were suitable for analysis

Total GS Markers
A total of 247 Individual GS Markers (n=247) were placed and suitable for analysis.

Appendix 14 - Survey Questionnaire Data Collection – Individual Factors

Introduction

This section describes in detail the specific characteristics and criteria utilised when collecting various socio-economic information of the individuals – both Individual Factor data and Non-Structural Landscape Factor data.

Secondary Socio-Economic Data

- Postal Code
- Household Income Level
- Education Level
- Deprivation Ranking (Paisley, Scotland)
- At Risk of Poverty (Vantaa, Finland)

Paisley, Scotland Case Study

Postal Code

Through the Mapita SoftGIS software, the survey respondent's home location was marked as a geolocation (i.e. spatial coordinates). These coordinates were provided within the survey questionnaire's results (SQ). Next, within Arcmap GIS, a simple postal code map (vector based) was overlaid upon the region which then was manually reviewed to determine the postal code for all respondents and incorporated (i.e. recoded) into the database (i.e. SPSS). This recoding included sub-dividing the postal code information into primary and secondary post codes. For example, a Paisley postcode of PA3 1NH was divided into two variables: primary postcode = PA3 and secondary postcode = 1NH.

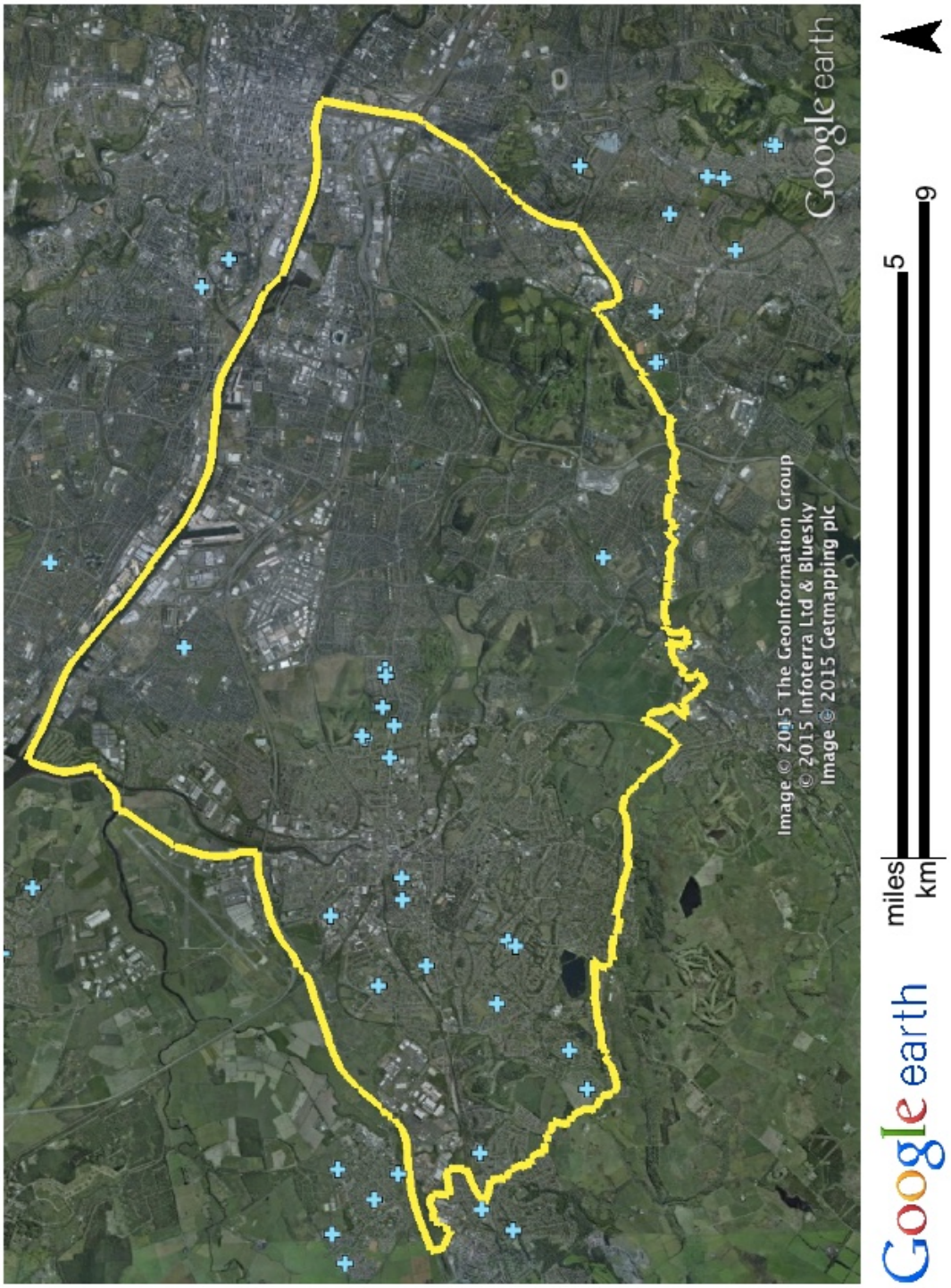


Figure A14.1
Home Locations (+) – Paisley CA

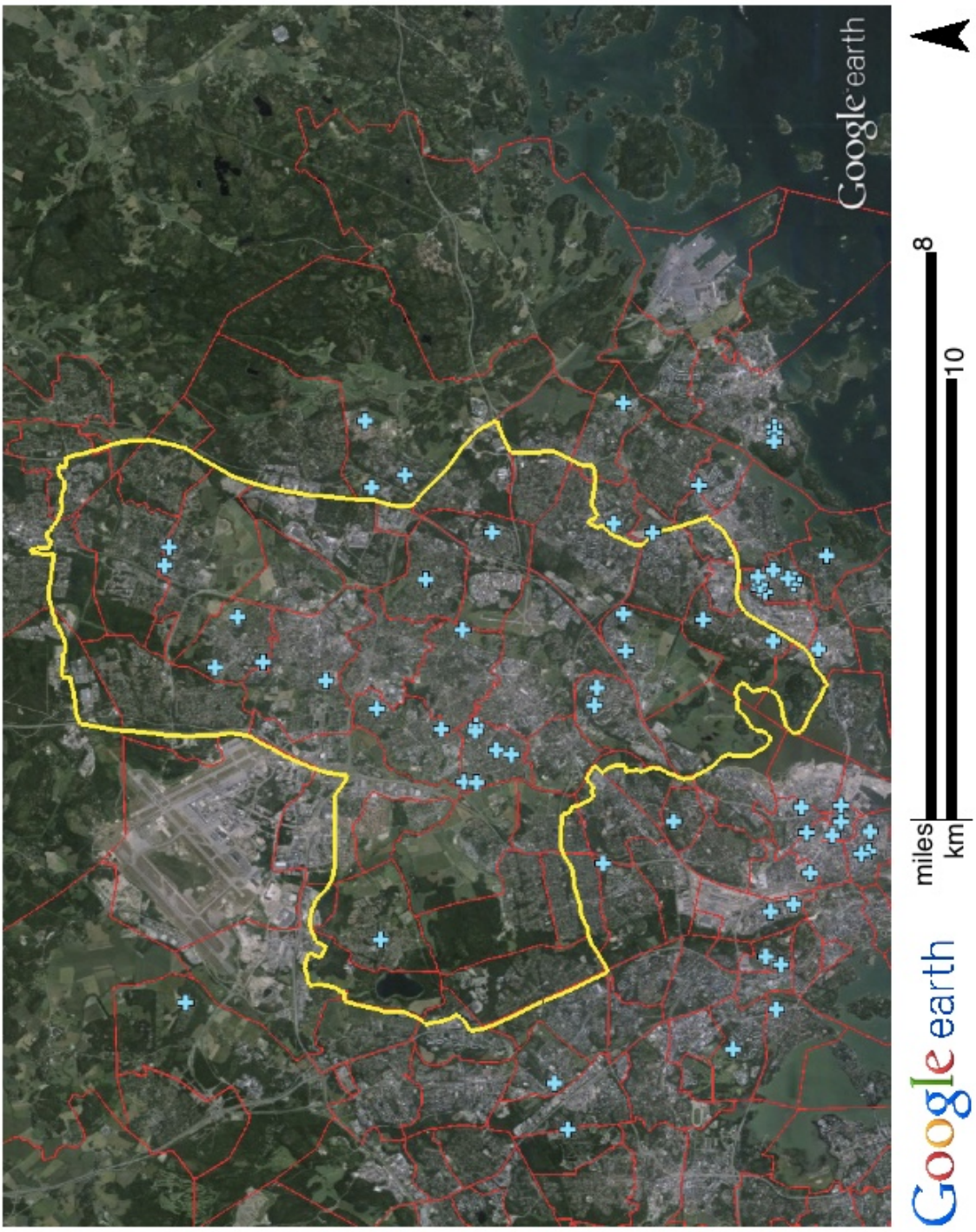


Figure A14.2
Home Locations (+) – Vantaa CA

Source: 2014 Ordinance Survey (thru Digimap Licence, EDINA)
Retrieved: 3 November 2014

Neither Scotland Census or Scottish Neighbourhood Statistics utilised postal code information in their datasets. Thus, a geodemographic database, Censation, produced by AFD Software Inc., was utilised to correlate the selected socio-

demographic datasets to the respondent's home geolocation through its postcode. As noted by the company which markets this data, *"There are around 50 or so 'model' classifications for all postcodes in the UK. They are a general view of various aspects of a postcode, and rarely do all parts of the description of a postcode classification match every aspect of the actual postcode itself."*

Geo-demographic data is grouped into 1 of 50 or so postcode classifications. This information reflects that classification, so it isn't always representative. This data is used for comparative analysis, and within this research, it presents a very general relationship with likely high degrees of variability and reliability. As such, this research utilised the following:

Household Income Level

The levels of data measurement for Household Income Level in the Glasgow Metropolitan Region in Scotland follow the Net Annual Household Income levels of the Scottish Household Survey (SHS) Annual Report 2009-10.

Annual net household income is defined by the SHS as *"the total annual net income (i.e. after taxation and other deductions) from employment, benefits and other sources, which is brought into the household by the highest income householder and/or their spouse or partner. This includes any contribution to household finances made by other household members. Due to refusals or don't knows, full information for the main components of household income was not collected from all households. Subsequently, SHS contractors impute the missing components of income for almost all of these households, using information that was obtained from other households that appeared similar"*. (Appendix A: Scottish Household Survey - Background information. Retrieved from http://www.transportscotland.gov.uk/statistics/j333840-72.htm, 4 November 2014)

These income levels are:

0-6000 BP
6001 - 10000 BP
10001 - 15000 BP
15001 - 20000 BP
10001 - 15000 BP
15001 - 20000 BP
20001 - 30000 BP
30001 - 40000 BP
40001+ BP

Source:
http://www.gov.scot/Topics/Statistics/16002/WebTablesAnnual2010
Retrieved: 4 November 2014

The data provided through the geodemographic database, Censation, was slightly different than Scottish Household Survey and required some recoding. Specifically, Censation provided the following income information, referred to as 'Qualifications':

Higher than average levels of people earning less than £5,000
Higher than average levels of people earning between £5,000 and £10,000
Higher than average levels of people earning between £10,000 and £15,000
Higher than average levels of people earning between £15,000 and £20,000
Higher than average levels of people earning between £20,000 and £25,000
Higher than average levels of people earning between £25,000 and £29,000
Higher than average levels of people earning between £30,000 and £40,000
Higher than average levels of people earning over £40,000

Source: http://www.checkmyfile.com
Retrieved: 4 November 2014

Thus, the Censation qualification levels were recoded to match the Net Annual Household Income levels of the Scottish Household Survey Annual Report 2009-10 as follows :

0-6000 BP = *Higher than average levels of people earning less than £5,000*
6001 - 10000 BP = Higher than average levels of people earning between £5,000 and £10,000
10001 - 15000 BP = Higher than average levels of people earning between £10,000 and £15,000
15001 - 20000 BP = Higher than average levels of people earning between £15,000 and £20,000
20001 - 30000 BP = Higher than average levels of people earning between £20,000 and £25,000
Higher than average levels of people earning between £25,000 and

£29,000

30001 - 40000 BP = Higher than average levels of people earning between £30,000 and £40,000

40001 +BP = *Higher than average levels of people earning over £40,000*

SHS notes the following limitations to their data: not a representative cross-section of population, results are estimates only of the larger population and vary due to multiple non-response factors and excluded population (e.g. military, prison, hospitals). SHS notes their confidence level within their data is 95%. The SHS gathers information about the current economic situation and the characteristics of individuals and households in different economic activity categories. The official source of statistics on employment, unemployment and economic activity is the Labour Force Survey for Scotland and the Annual Population Survey at a local authority level - see Labour Market Statistics for further information.

Education Level

The levels of data measurement for Income Level in the Glasgow Metropolitan Region in Scotland follow the Scotland Census 2011. These categories differ from those used in other published statistics, in particular those based on the Scottish Credit and Qualifications Framework (SCQF).

No Qualifications

Census Level 1
O Grade, Standard Grade, Access 3 Cluster, Intermediate 1 or 2, GCSE, CSE, Senior Certificate or equivalent; GSVQ Foundation or Intermediate, SVQ level 1 or 2, SCOTVEC Module, City and Guilds Craft or equivalent; Other school qualifications not already mentioned (including foreign qualifications)

Census Level 2
SCE Higher Grade, Higher, Advanced Higher, CSYS, A Level, AS Level, Advanced Senior Certificate or equivalent; GSVQ Advanced, SVQ level 3, ONC, OND, SCOTVEC National Diploma, City and Guilds Advanced Craft or equivalent

Census Level 3
HNC, HND, SVQ level 4 or equivalent; Other post-school but pre-Higher Education qualifications not already mentioned (including foreign qualifications)

Census Level 4 and above

Degree, Postgraduate qualifications, Masters, PhD, SVQ level 5 or equivalent; Professional qualifications (for example, teaching, nursing, accountancy); Other Higher Education qualifications not already mentioned (including foreign qualifications)

Source: http://www.scotlandscensus.gov.uk/education-0
Retrieved: 4 November 2014

The data provided through the geodemographic database, Censation, was slightly different than Scotland Census and required some recoding. Specifically, Censation provided the following education information, referred to as 'Qualifications':

Higher than average levels of people with no qualifications
A low number of graduates, most educated to GCSE standard
An average number of graduates, with most educated to A-level
A higher number of graduates than average
A very high number of graduates, some postgraduates and many with professional qualifications

Source: http://www.checkmyfile.com
Retrieved: 3 November 2014

Thus, the Censation qualification levels were recoded to match the Scottish Census Education Levels as follows:

No qualifications = *Higher than average levels of people with no qualifications*

Census Level 1 = *A low number of graduates, most educated to GCSE standard*

Census Level 2 = *An average number of graduates, with most educated to A-level*

Census Level 3 = A higher number of graduates than average

Census Level 4 and above **=** A very high number of graduates, some postgraduates and many with professional qualifications

SIMD Quintile Ranking

The levels of data measurement for the Scottish Index of Multiple Deprivation (SIMD) in the Glasgow Metropolitan Region follow the SIMD levels of the Scottish Neighbourhood Statistics.

The Scottish Index of Multiple Deprivation (SIMD) has many levels of measurement (See below). This study chose a unique quintile, or 5-level, measurement of Deprivation as provided by Scottish Neighbourhood Statistics (SNS). This metric provided a simple, thorough overview of multiple socio-economic characteristics.

As noted by the SNS: "The Scottish Index of Multiple Deprivation (SIMD) provides a relative ranking of the data zones in Scotland from 1 (most deprived) to 6505 (least deprived) based on a weighted combination of data in the domains of Current Income, Housing, Health, Education, Skills and Training, Employment and Geographic Access and Crime (no Crime data available for SIMD 2004). Each of the domains can also be ranked individually." (http://www.gov.scot/simd; Retrieved 4 December 2014)

This quintile ranking focussed on the Most Deprived locations within Scotland and the Glasgow Metropolitan Region. This SIMD gradient utilised the most deprived data zones as:

0-5% (Most Deprived)
5-10%
10-15%
15-20%
20% - 100% (Least Deprived)

Source: http://www.sns.gov.uk/Simd/Simd.aspx
Retrieved: 2 December 2014

This data was exported as a map graphic with the various zones or physical areas of deprivation and imported into ArcMap. The postal code map (as above) was overlaid in order to determine the survey respondent's 'home' location level of deprivation.

SIMD Decile Ranking

Whereas the SIMD Level was an effective technique for quickly locating the most deprived 'home' locations (i.e. 0-20%), a more detailed level of deprivation was desired in further understanding the survey respondent's socio-demographic and socio-economic characteristics. The following decile, or 10-level, measurement was provided by Scottish Neighbourhood Statistics (SNS) and is not weighted (as prior).

SIMD Rank		
Decile (10%)	From	To
1	1	651
2	652	1301
3	1302	1952
4	1953	2602
5	2603	3253
6	3254	3903
7	3904	4554
8	4555	5204
9	5205	5855
10	5856	6505

Table A27-1
SIMD 2012 decile
The Scottish Government
REVISED 10 January 2013

Source: SIMD Background Data - SIMD ranks to quintiles, deciles and vigintiles.
http://www.scotland.gov.uk/Topics/Statistics/SIMD/simdbackgrounddataannexb
Retrieved: 2 December 2014

This data was exported as a map graphic with the various zones or physical areas of deprivation and imported into ArcMap. The postal code map was overlaid in order to determine the survey respondent's 'home' location decile level of deprivation.

Vantaa, Finland Case Study

Postal Code

Vantaa's CA data synthesis utilised the same procedures as Paisley, Scotland. The postal code vector map utilised to determine the respondent's 'home' physical location was the "HELSINKI METROPOLITAN POSTAL CODE AREAS".

Source: Statistics Finland (open source data)
http://www.stat.fi/tup/paavo/index_en.html
Retrieved: 7 November 2014
This dataset was produced 1/2014.

Much of Finland's and the Helsinki Metropolitan Area's statistical data is correlated through postal codes. No data integration was required, as was necessary within Scotland's dataset.

Household Income Level

The levels of data measurement for Household Income Level in the Helsinki Metropolitan Region follow the Household's Disposable Monetary Income levels of Statistics Finland. This measure was determined to be most similar to Scotland's Income Level measures.

As defined by Statistics Finland, Household's Disposable Monetary Income " data pertain to households. A household is formed of people who live permanently in the same dwelling. The statistical definition for a household is household-dwelling unit. The income data are based on the disposable monetary income of households. The formation of disposable monetary income can be described as follows:

+ wages and salaries
+ entrepreneurial income
+ property income (without imputed rent)
+ current transfers received (without imputed rent)
(= gross money income)
- current transfers paid
= disposable monetary income."

(Statistics Finland, Paavo - Open data by postal code area, retrieved from: http://www.stat.fi/tup/paavo/index_en.html).

Source: Statistics Finland (open source data)
http://www.stat.fi/tup/paavo/index_en.html
Retrieved: 7 November 2014

These income levels are:

0 -4,999 EURO
5 000 – 9 999
10 000 - 14 999
15 000 - 19 999
20 000 - 24 999
25 000 - 29 999
30 000 - 34 999
35 000 - 39 999
40 000 - 49 999
50 000 - 59 999
60 000 - 79 999
80 000 + EURO

Source: Tulonsaajat ja tulot tuloluokittain Helsingissä 2012 (Income recipients and income by income bracket in Helsinki 2012)
Retrieved: 4 November 2014

Similar to Scotland's Income Levels, the top-level cut-off was set at 60000 EURO (i.e Scotland 40 000 BP). Additionally, the other income levels were grouped to reflect Scotland's levels. The following income levels for Helsinki were finalised as:

0 - 9999 EURO
10 001 - 19999
20 000 - 29999
30 000 - 34 999
35 000 - 39 999
40 000 - 44 999
45 000 - 49 999
50 000 - 59 999
60 000 + EURO

Education Level

The levels of data measurement for Education Level (Education Structure) in the Helsinki Metropolitan Region follow the Statistics Finland levels and is noted as follows:

> *"Data on educational structure for the population living in an area concern people aged 18 or over. Only one type of education has been taken into account for each person, i.e. the highest qualification acquired of the latest acquired qualification if a person has several same level qualifications. Where a person has completed the matriculation examination and a lower-level vocational qualification, the education is determined by the vocational qualification. Data on educational structure are confidential if the area contains fewer than 30 people aged 18 or over."*

Basic level studies, 2012
Basic level studies: no qualification after basic level or qualification unknown.

With education, total, 2012
With education: people with at least an upper secondary qualification.

Matriculation examination, 2012
Matriculation examination: people having completed the matriculation examination.

Vocational diploma, 2012
Vocational diploma: qualifications at lower and higher upper secondary level (level 3, excluding matriculation examination), as well as qualifications at the lowest level of tertiary education (level 5).

Academic degree - Lower level university degree, 2012
University / tertiary-level degree, lower: lower-degree level tertiary education (level 6).

Academic degree - Higher level university degree, 2012
University / tertiary-level degree, higher: higher-degree level tertiary education (level 7) and doctorate degrees or equivalent (level 8).

Source: Statistics Finland (open source data)
http://www.stat.fi/tup/paavo/index_en.html
Retrieved: 7 November 2014

Only one level, "With education", was deleted as it was considered too similar to "Basic level studies". The following education levels for Helsinki were finalised:

No Qualifications
Basic Level Studies
Matriculation Exam
Vocational Diploma
Academic Degree - Lower Level University
Academic Degree - Higher Level University

Poverty Risk Ranking

The levels of data measurement for Poverty Risk Ranking in the Helsinki Metropolitan Region were accessed from Statistics Finland. This measure was determined to be most similar to Scotland's SIMD measures.

As defined by Statistics Finland, at risk of poverty rate: The share of persons at risk of poverty in the chosen population. Persons at risk of poverty: Number of persons at risk of poverty in the chosen population. Median equivalent income of the population at risk of poverty in the chosen population. Poverty gap: Distance of

median income among population at risk of poverty from the at risk of poverty threshold. Equivalent income: Household disposable money income per consumption unit in a year.

The at risk of poverty thresholds are set each year according to the median equivalent income of all households. The official low income threshold used in the publications is 60 % of median income and the income concept is disposable money income.

The formation of disposable monetary income can be described as follows:

0 - 40 % of the median equivalent income of all households
Hi risk

40% - 49% of the median equivalent income of all households
Medium risk

50% - 59% of the median equivalent income of all households of Median Income
Low risk

60% - 100% of the median equivalent income of all households
No risk

Source: Statistics Finland (open source data)
http://www.stat.fi/tup/paavo/index_en.html
Retrieved: 7 November 2014

Appendix 15 - Survey Questionnaire Results Data Coding

Introduction

The following sections illustrate how the primary and secondary data collected from the survey questionnaire were coded prior to statistical analysis. This includes both GS structural and non-structural factors as well as the Individual, Landscape and HWB Interaction Factors.

Individual Factors

Respondent Age (18 - 75, split into 6 ranking values)

1 = "18-24"
2 = "25-34"
3 = "35-44"
4 = "45-54"
5 = "55-64"
6 = "65-75"

Respondent Gender	(M/F) (0-1)
Family Dog Ownership	(Y/N) (0-1)
Family Car Ownership	(Y/N) (0-1)
Primary Post Code	as noted
Secondary Post Code	as noted

Household Income Level (identified only by Primary Post Code)

Paisley, Scotland

(annual income in GPB)
1 = “0-6000”
2 = “6000-10000"
3 = “10000-15000”
4 = “15000-20000"
5 = “20000-30000"
6 = “30000-40000"
7 = "40000+"

Vantaa, Finland

(annual income in EURO)
1 = “0-10000”
2 = “10000-20000"
3 = “20000-30000”
4 = “30000-35000"
5 = “35000-40000"
6 = “40000-45000"
7 = "45000-50000"
8 = “50000-60000"
9 = "60000+"

Education Level (identified only by Primary Post Code)

Paisley, Scotland

1 = "No Qualifications"
2 = "GSCE and SVQ Level 1 or 2"
3 = "A Levels, a few GSCEs, SVQ Level 3"
4 = "Graduates, SVQ Level 4"
5 = "Postgraduate Qualifications"

Vantaa, Finland

1 = "Basic Level Studies"
2 = "Matriculation Exam"
3 = "Vocational Diploma"
4 = "Academic Degree - Lower Level University"
5 = "Academic Degree - Higher Level University"

Deprivation Ranking (identified only by Primary Post Code)

Paisley, Scotland

1 = "0-5% Most Deprived"
2 = "5%-10%"
3 = "10% - 15%"
4 = "15% - 20%"
5 = "20% - 100%"

Depravity Quintile Ranking Scores (identified only by Primary Post Code)

1 = "1%-10%"
etc (1-10 = 1-100%)

Vantaa, Finland

At Risk of Poverty

1 = "Income 0-40% of Median Income (HI RISK)"
2 = "Income 40%-49% of Median Income (MEDIUM RISK)"
3 = "Income 50%-59% of Median Income (LOW RISK)"
4 = "Income > 60% of Median Income (NO RISK)"

Life Satisfaction

Life Satisfaction

1 = "Very Satisfied"
2 = "Satisfied"
3 = "Neither Satisfied or Unsatisfied"
4 = "Unsatisfied"
5 = "Very Unsatisfied"

Landscape Factors
Green Space Non Structural Factors

Distance (m) to nearest Green Space (m)
1 = "0-400 M (0-5 MIN WALK)" 2 = "400-800 M (5-10 MIN WALK)" 3 = "OVER 800 M (OVER 10 MIN WALK)" 4 = "NO HOME PROVIDED"

Was Nearest GS Listed as FGS/OGS	(Y/N) (0-1)
GS Named or Titled or Not	(Y/N) (0-1)
GS within Catchment Area	(Y/N) (0-1)
Mode of Access to GS	(Walk, Bike, Car, Bus,Train (Tram)).
GS Typological Definition	(12 GS typologies)
GS Ownership	(Public, Private, Unknown)
GS Special Designation	(Y/N, Undeterminable)

FGS Named or Titled or Not (Y/N) (0-1) OGS Named or Titled or Not (Y/N) (0-1)

Landscape Factors
Green Space Structural Factors

As noted within Table x.x : GS Index Char Measeuremnet LEbels

HWB Interaction Factors

What do in FGS?
1 = "Recreate & Play Sports (PHYSICAL HWB BENEFIT)"
2 = "Family Friends Socialise Kids Play (SOCIAL HWB BENEFIT)"
3 = "Relax Quiet Enjoy Nature (PSYCHOLOGICAL HWB BENEFIT)"

What do in OGS?
1= Play sports and games or ride the bike. (PHYSICAL HWB BENEFIT)
2= Sit and relax, read, be peaceful and enjoy nature. (PSYCHOLOGICAL HWB BENEFIT)
3= Get together with friends and family, have picnics. (SOCIAL HWB BENEFIT)
4= Walk the dog. (PHYSICAL HWB BENEFIT)
5= Bring the kids to play. (SOCIAL HWB BENEFIT)
6= Socialise with others, catch-up or gossip. (SOCIAL HWB BENEFIT)
7= Walk, run, jog or hike. (PHYSICAL HWB BENEFIT)
8= View wildlife and special natural areas. (PSYCHOLOGICAL HWB BENEFIT)
9= Garden and Farm. (PSYCHOLOGICAL HWB BENEFIT)

Appendix 16 - Survey Questionnaire Results - Simple Statistics

Paisley, Scotland
PPUIGS Characteristics (X1)

Simple Statistics							
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
GS_Size_Area	174	1.44828	0.74117	252.00000	1.00000	3.00000	Size - Area Characteristics
GS_Density	181	1.48619	0.77894	269.00000	1.00000	3.00000	Size - Density Characteristic
GS_Largest	166	1.83133	0.66641	304.00000	1.00000	3.00000	Size - Largest Characteristic
GS_Shape	180	2.00556	0.87483	361.00000	1.00000	3.00000	Shape - Regulation Greeness Characteristic
GS_Regulation	174	2.01724	1.03396	351.00000	1.00000	4.00000	Shape - Regulation
GS_Complexity	173	2.23121	0.99636	386.00000	1.00000	4.00000	Shape - Complexity and Diversity
GS_NN	182	1.37363	0.62451	250.00000	1.00000	3.00000	Proximity - Nearest GS Neighbour
GS_Isolation	179	1.67039	0.83985	299.00000	1.00000	3.00000	Proximity - Isolation and Connectivity
GS_Coherence	161	1.59006	0.60696	256.00000	1.00000	3.00000	Proximity - Level of Coherence
GS_TotalEdge	156	1.85256	0.78539	289.00000	1.00000	3.00000	Edge - Total Edge
GS_LongestEdge	160	1.79375	0.52721	287.00000	1.00000	3.00000	Edge - Longest Edge
GS_EdgeDensity	179	2.04469	0.78484	366.00000	1.00000	3.00000	Edge - Edge Density
GS_LevelOfGreen	181	1.84530	1.07927	334.00000	1.00000	4.00000	Level of Green - Vegetation Composition
GS_Setting	182	2.53297	0.97850	461.00000	1.00000	4.00000	Level of Green - Vegetation Composition - Setting
GS_Horizontal	181	2.28177	0.81182	413.00000	1.00000	3.00000	Level of Green - Vegetation Structure - Horizontal
GS_Vertical	181	2.06077	0.72392	373.00000	1.00000	3.00000	Level of Green - Vegetation Structure - Vertical
GS_V_Density	180	2.03889	0.89295	367.00000	1.00000	3.00000	Level of Green - Vegetation Structure - Density
GS_RoadProximity	182	1.71978	0.78208	313.00000	1.00000	3.00000	Level of Green - Proximity to Heavy Traffic Road
GS_Visibility	182	1.62637	0.71524	296.00000	1.00000	3.00000	Level of Green - Vegetation Structure - Visibility
GS_Cleanliness	182	1.47802	0.51181	269.00000	1.00000	3.00000	Maintenance and Management - Cleanliness
GS_Facilities	182	1.87363	0.84779	341.00000	1.00000	3.00000	Maintenance and Management - Facilities
GS_Paths	181	1.83425	0.80632	332.00000	1.00000	3.00000	Maintenance and Management - Facilities - Paths
GS_SocialSpaces	180	1.51667	0.66412	273.00000	1.00000	3.00000	Maintenanec and Management - Facilities - Sociability
GS_Safety	182	1.65385	0.58145	301.00000	1.00000	3.00000	Safety and Security

Demographic and Socio-Economic Data (X2)

Simple Statistics							
`	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Age	55	3.83636	1.25851	211.0	1.0	6.0	Respondent's Age
Gender	55	0.47273	0.50386	26.0	0	1.0	Respondent's Gender
Depravity_Quintile_Ranking	55	6.40000	3.33667	352.0	1.0	10.0	Depravity Quintile Ranking Scores (AVG per PostCode)
AVG_Household_Income	55	4.23636	1.99038	233.0	1.0	7.0	Household Income Level (AVG per PostCode)

Simple Statistics							
`	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
AVG_Education_ Level	55	3.45455	1.43782	190.0	1.0	5.0	Education Level (AVG per PostCode)

Human Well-Being Benefit Afforded from GS Interaction (X3)

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
What do in Other GS1	69	2	1	3	114	1.65	.103	.855	.730
What do in Other GS1	36	2	1	3	67	1.86	.107	.639	.409
What do in Other GS1	23	2	1	3	60	2.61	.122	.583	.340
Valid N (listwise)	23								

Self Reported Life Satisfaction (Y)

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Life_Satisfaction	48	1.75000	1.46593	84.0	1.0	5.0	LIFE SATISFACTION

Vantaa, Finland

PPUIGS Characteristics (X1)

Simple Statistics							
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
GS_Size_Area	246	1.47154	0.65559	362.00000	1.00000	3.00000	Size - Area Characteristics
GS_Density	222	1.64414	0.64129	365.00000	1.00000	3.00000	Size - Density Characteristic
GS_Largest	246	1.89024	0.77732	465.00000	1.00000	3.00000	Size - Largest Characteristic
GS_Shape	246	1.54065	0.73705	379.00000	1.00000	3.00000	Shape - Regulation Greeness Characteristic
GS_Regulation	246	2.38211	1.06154	586.00000	1.00000	4.00000	Shape - Regulation
GS_Complexity	246	2.21951	0.96921	546.00000	1.00000	4.00000	Shape - Complexity and Diversity
GS_NN	246	1.23984	0.53776	305.00000	1.00000	3.00000	Proximity - Nearest GS Neighbour
GS_Isolation	245	1.30204	0.59935	319.00000	1.00000	3.00000	Proximity - Isolation and Connectivity
GS_Coherence	246	1.26423	0.51834	311.00000	1.00000	3.00000	Proximity - Level of Coherence
GS_TotalEdge	246	1.90244	0.81731	468.00000	1.00000	3.00000	Edge - Total Edge
GS_LongestEdge	244	1.94672	0.77594	475.00000	1.00000	3.00000	Edge - Longest Edge
GS_EdgeDensity	244	1.89754	0.84239	463.00000	1.00000	3.00000	Edge - Edge Density
GS_LevelOfGreen	244	2.23770	0.68557	546.00000	1.00000	4.00000	Level of Green - Vegetation Composition
GS_Setting	244	1.91393	1.02076	467.00000	1.00000	4.00000	Level of Green - Vegetation Composition - Setting
GS_Horizontal	244	2.18852	0.88268	534.00000	1.00000	3.00000	Level of Green - Vegetation Structure - Horizontal
GS_Vertical	244	1.69262	0.78028	413.00000	1.00000	3.00000	Level of Green - Vegetation Structure - Vertical
GS_V_Density	244	1.86885	0.84084	456.00000	1.00000	3.00000	Level of Green - Vegetation Structure - Density
GS_RoadProximity	244	1.81148	0.82484	442.00000	1.00000	3.00000	Level of Green - Proximity to Heavy Traffic Road
GS_Visibility	244	2.24590	0.74603	548.00000	1.00000	3.00000	Level of Green - Vegetation Structure - Visibility
GS_Cleanliness	244	1.61066	0.50517	393.00000	1.00000	3.00000	Maintenance and Management - Cleanliness
GS_Facilities	244	2.07377	0.73331	506.00000	1.00000	3.00000	Maintenance and Management - Facilities
GS_Paths	244	2.39754	0.77097	585.00000	1.00000	3.00000	Maintenance and Management - Facilities - Paths
GS_SocialSpaces	244	1.93443	0.71708	472.00000	1.00000	3.00000	Maintenanec and Management - Facilities - Sociability
GS_Safety	244	1.84426	0.64814	450.00000	1.00000	3.00000	Safety and Security

Demographic and Socio-Economic Data (X2)

Simple Statistics							
`	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Age	62	2.91935	1.30947	181.0	1.00000	6.00000	Respondent's Age
Gender	62	0.51613	0.50382	32.0	0	1.00000	Gender
Depravity_Quintile_ Ranking	62	4.00000	0	248.0	4.00000	4.00000	At Risk of Poverty Threshold Ranking
AVG_Household_ Income	62	5.01613	1.54168	311.0	3.00000	9.00000	Household Income Level (AVG per PostCode)
AVG_Education_ Level	62	2.82258	0.38514	175.0	2.00000	3.00000	Education Level (AVG per PostCode)

Human Well-being Benefit Afforded from GS Interaction (X3)

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
What do in Favourite GS1	100	2	1	3	156	1.56	.086	.857	.734
What do in Favourite GS1	54	2	1	3	118	2.19	.096	.702	.493
What do in Favourite GS1	16	2	1	3	33	2.06	.249	.998	.996
Valid N (listwise)	16								

Self Reported Life Satisfaction (Y)

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Life_Satisfaction	52	1.57692	1.14354	82.0	1.0	5.0	LIFE SATISFACTION

Life Satisfaction and Socio-Economic Variable Descriptive Results

Household Income and Life Satisfaction

Paisley CA

The following % is VERY SAT and SAT ONLY

0-5000 BP	6	60% within that group
5-10	2	66.7% within that group
10-15	2	100%
15-20	3	60%
20-30	13	92.9%
30-40	7	77.8%
40+	4	80%

The following % is VERY UNSSAT and UNSAT ONLY

0-5000 BP	1	10% within that group
5-10	1	33.3% within that group
10-15	0	0%
15-20	2	40%
20-30	0	0%
30-40	2	22.2%
40+	1	20%

Vantaa CA

The following % is VERY SAT an SAT only (n=40):

0-10,000 EURO	0	0%
10-20	0	0%
20-30	5	83.3% within that group
30-35	15	78.9%
35-40	11	78.6%
40-45	2	100%
45-50	5	71.4%
50-60	1	50%
60+	12	50%

The following % is VERY UNSSAT and UNSAT ONLY (n=3):

0-10,000 EURO	0	0%
10-20	2	11% within that group
20-30	1	7% within that group
30-35	0	0%
35-40	0	0%
40-45	0	0%
45-50	0	0%
50-60	0	0%
60+	0	0%

Figure A16.1
Life Satisfaction and Household Income

In the Paisley CA, 92.9% of the income level GBP 20,000-30,000 reported VeryS or S LS, whereas 40% of the GBP 15,000-20,000 income level group reported a VeryU or U LS. In the Vantaa CA, 78.9% of the 30,000-35,000 Euro income level reported VeryS or S LS, and 7.1% of the same group reported a VeryU or U LS.

Paisley CA
The Income level with the highest percentage of Life Sat (Highly Sat or Sat) = 20-30K BP, 92.9% within that group.

The Income level with the moderate percentage of Life Sat (NEITHER Highly Sat or Sat) = 0-5K, 30% within that income level group.

The Income level with the lowest percentage of Life Sat (Highly Unsat or Unsat) =15-20K, 40% within that income level group.

Vantaa CA
The income level with the highest percentage of Life Sat (Highly Sat or Sat) =30-35K (78.9% within that group).
The income level with the moderate percentage of Life Sat (NEITHER Highly Sat or Sat) = 45-50K (28.6% within that income level group).
The income level with the lowest percentage of Life Sat (Highly Unsat or UnsSat) =30-35K (7.1% within that group).

Figure A16.2
Life Satisfaction and Household Income – Highest Percentages
MINIMUM 3 entries to qualify for analysis

Paisley CA
Depravity Decile Ranking and Life Satisfaction

Very Satisfied or Satisfied		
Income 1-10% median	3	60% within that group/line
Income 11-20% median	2	66.7%
Income 21-30% median	6	100%

Income 31-40% median	4	100%
Income 41-50% median	1	50%
Income 51-60% median	1	33.3%
Income 61-70% median	2	66.7%
Income 71-80% median	0	0%
Income 81-90% median	5	71.4%
Income 91-100% median	13	86.7%

Neither Satisfied or Unsatisfied

Income 1-10% median	1	20% within that group/line
Income 11-20% median	0	0%
Income 21-30% median	0	0%
Income 31-40% median	0	0%
Income 41-50% median	1	50%
Income 51-60% median	1	33.3%
Income 61-70% median	0	0%
Income 71-80% median	0	0%
Income 81-90% median	0	0%
Income 91-100% median	1	6.7%

Very Unsatisfied or Unsatisfied

Income 1-10% median	1	20%
Income 11-20% median	1	33.3%
Income 21-30% median	0	0%
Income 31-40% median	0	0%
Income 41-50% median	0	0%
Income 51-60% median	1	33.3%
Income 61-70% median	1	33.3%
Income 71-80% median	0	0%
Income 81-90% median	2	6.7%
Income 91-100% median	1	14.6%

Vantaa CA

Poverty Threshold Level and Life Satisfaction

Of the 62 respondents, 52 gave a LS ranking, and all 52 were above the 60% poverty threshold:

40	were Highly Sat or Sat	76.9%
9	were neither Sat or Unsat	17.3%
3	were Highly Unsat or Unsat	5.8%

Figure A16.3
Life Satisfaction and Deprivation and Poverty

For the Paisley CA, 100% of the SIMD decile groups of 31%-40% median income and 21%-30% median income reported VeryS or S LS. The SIMD decile levels with the lowest percentage of Life Satisfaction (Very U or U) were the 11%-20%, 51%-60% and 61%-70% median income groups; however, these had only one entry each.

Within the Vantaa CA, all respondents were above the 60% poverty threshold. 76.9% reported VeryS or S LS, 17.3% reported being neither S nor U, and 5.8% reported being VeryU or U.

Education Level and Life Satisfaction

Paisley CA

Very Satisfied or Satisfied		
No Quals	4	66.7% within that group
SVQ Level 1 or 2	5	55.6%
SVQ Level 3	5	83.3%
SVQ Level 4	8	88.9%
Post Quals	15	83.3%

Very Unsatisfied or Unsatisfied		
No Quals	1	16.7% within that group
SVQ Level 1 or 2	2	22.%
SVQ Level 3	1	16.7%
SVQ Level 4	1	11.1%
Post Quals	2	11.1%

Vantaa CA

Only two education levels were reported.

Matriculation Exam	9	17.3%
Vocational Diploma	43	82.7%

Matriculation Exam n=9

6	were Highly Sat or Sat	66.7%
3	were neither Sat or Unsat	33.3%
0	were Highly Unsat or Unsat	

Vocational Diploma n=43

34	were Highly Sat or Sat	79.1%
6	were neither Sat or Unsat	14.0%
3	were Highly Unsat or Unsat	7.0%

Figure A16.4
Life Satisfaction and Education Levels

Within the Paisley CA, 83.3% of the education level of Post Quals reported VeryS or S LS. The education levels with the lowest percentage (22%) of Life Satisfaction (highly unsatisfied or unsatisfied) were SVQ Level 1 or 2; however this had only two entries.

Within the Vantaa CA, only two education levels were reported: 17.3% for Matriculation Exam level and 82.7% for Vocational Diploma level. 79.1% of those with the Vocational Diploma education level reported VeryS or S LS. The education

level with the lowest percentage (7%) of Life Satisfaction (VeryU or U), was also the Vocational Diploma level; however this had only three entries.

Appendix 17 - Survey Questionnaire Results Secondary Data Collection - Non Structural Landscape Factors – Grouping 2

Introduction

This section describes in detail the specific characteristics and criteria utilised within Grouping 2 of the non-structural landscape factor data of GS as identified within the SQ (i.e. part of the GS Profile).

- GS Ownership
- GS Titled or Named
- GS Typologial Definition
- GS Special Designation
- GS within Case Study Area SQ Boundary
- Mode of access to GS selected
- Distance to Nearest GS
- Was Nearest GS visited

Non Structural Landscape Factors – Grouping 2

GS Ownership

Levels: Public, Private, or Unknown

This designation builds from the work of GIGL:

Green spaces are designated as Public Open Space if:

1. They are not marked as being non-Public Open Space. From previous work, some spaces have been designated specifically as not being Public Open Space.

2. They do not have 'restricted' or 'none' public access.

3. They are designated as any of the following principal space types; park, formal garden, common, public woodland, nature reserve, recreation ground, playing fields, village green, amenity green space, play space, civic/market square, river, canal, walking/cycling route.

Source:

http://www.gigl.org.uk/our-data-holdings/open-spaces/public-open-space-categories/

GS Titled or Named

Levels: Yes or No

This characteristic determined if the GS identified had a specific title or formal designation to it.

GS Typology

Levels: 1 of 12 Typologies

This characteristic determined, to the best degree possible and utilising the visual analysis instruments, particularly site visits and remote sensing, what GS typology the identified GS best correlated to.

PERI-URBAN GREEN SPACE TYPOLOGY	TYPOLOGY EXAMPLES
PARK	Public or Private Parks and/or Public Common Areas ***not associated*** with Housing *(e.g village green, dog areas, playgrounds, sitting areas)* Often with traditional green space elements such as benches, fountains, picnic spaces, toilets and other facilities. At various sizes including Reserves. Regional Parks, Metropolitan Parks, District Parks, Local Parks, Small Parks, Pocket Parks.
GARDENS AND GROUNDS	Domestic Gardens. Formal Gardens. Memorial Gardens. Back Gardens. Pleasure Gardens. Public or Private. **Not** an Amenity Green Space (see below). Institutional Grounds, School Grounds, Commercial grounds.
WOODLAND	Deciduous / Evergreen / Mixed / Wet Woodland
GRASSLAND	Meadow / Grassland / Heathland / Scrubland
OTHER NATURAL AND SEMI-NATURAL GREEN SPACE	Conservation sites, heritage sites. Can be wild or designed.
OUTDOOR SPORTS FACILITIES	Play fields and Outdoor Sport Areas such as football pitches, bowling greens, tracks, golf courses, tennis, cricket fields, fishing, etc. Informal recreation areas or an Athletic Complex or Facility
CHILDREN'S PLAY AREA	Playground - Adventure or Equipped.
AMENITY GREEN SPACE	Housing Green Space and Common Areas such as Village Green. Commercial amenity greens space.
GREEN CORRIDOR or RIPARIAN CORRIDOR	Greenway, Parkway, River Walk, Canal Banks, Towpaths, Bridleways. Transport Corridors such as road, rail, cycleways, walking routes.
AGRICULTURAL	Crop land, Fallow Land, Pasture Land. Orchards or Planted Fields. Farmland. Arable and Grazing Land.
ALLOTMENTS, COMMUNITY GARDENS AND CITY FARMS	Nurseries. Garden Commons.
CEMETERIES AND CHURCHYARDS	Burial Grounds, Disused Cemeteries, Crematoriums.
CIVIC SPACES	Civic squares or markets. often with paved surfaces and green areas and trees. Plazas. Transport hub spaces. Not an Amenity Green Space.
RESERVOIR or WATER & WETLAND INCLUDING COASTAL LANDS	Canals, Reservoirs, Dams (Running Water / Standing Water)
OTHER GREEN SPACE	Other natural, semi-natural and semi-urban spaces. Landfills. Vacant Land, quarries, brown fields. Functional green space such as caravan parks. Incidental Green Space or Open Space.

Table x.x

CA PPUIGS Typologies

GS Special Designation

Levels: Yes, No, or Undeterminable

A comprehensive list of Special Designations were compiled from various data sources and included Scotland, UK, Finland and EU based designations, among others. If any of the GS identified were noted as having any of the following classifications, they were marked a 'Yes' for Special Designation.

SSSI - Site of Special Scientific Interest

SNCI - Site of Nature Conservation Importance

Area of Outstanding Beauty

Area of Great Landscape Value

Urban Landscape Protection Area

Other Preservation or Conservation Area

Other Special Areas or Sites

Historic Conservation Area

Other

Sources:

Scotland and the UK: See below, and

http://www.opengreenspace.com/legislation-for-green-space-updates/designations/

Finland: Ministry of Environment , Natura 2000, National Landscapes designation, OECD Regional Database.

Specific Information regarding the Paisley, Scotland Catchment Area GS Designations

Sites of Special Scientific Interest (SSSI)

SSSIs are the main nature conservation designations in the UK. SSSIs are sites which are special for their:

Plants;
Animals;
Habitats;
Rocks;
Landforms;
or a combination of these features.

SSSIs are designated by Scottish Natural Heritage after detailed scientific survey. In March 2012, there were 1,439 SSSIs in Scotland, eleven of which are in Renfrewshire, two if which were in the Catchment Area.

SSSI - Sites of Special Scientific Interest

1. *Castle Semple and Barr Lochs Lochwinnoch: lowland wetland and fringing woodland which provide nesting and wintering habitat for a wide range of bird species.*

2. Rouken Glen.

SNCI - Site of Nature Conservation Importance

Clydemuir

Dams to Darmley

Busby Glen

Roiuken Glen

OS near Paterson Trail

Not designated but within 30m:

GS near Lohclibo Road

GS near Glen Park

Special Protection Areas (SPAs)

Special protection areas are designated as part of the United Kingdom's nature conservation responsibilities under European law. They are part of the network of Natura 2000 protected sites and support nationally or internationally important numbers of birds. In Scotland, Scottish Natural Heritage make the designations of special protection areas for the Scottish Government on the basis of scientific surveys. More information on SPAs is available from the Scottish Natural Heritage website.

None in CA

Source :*http://www.renfrewshire.gov.uk/webcontent/home/services/planning+and+building+standards/nature+conservation+and+greenspace/pt-cl-natureconserv*

Conservation Areas

Renfrewshire's eight conservation areas are:

	Castlehead, Paisley
	Greenlaw, Paisley
	Houston
	Kilbarchan
	Lochwinnoch
	Ranfurly, Bridge of Weir
	Paisley Town Centre
	Thornly Park, Paisley
Heritage	
	Kelvin grove Park
	Pollock Park
	Bellahouston Park
	Victoria Park
	King George V Memorial
	William Wallace Memorial

Under Planning laws the council has a duty to protect, preserve and enhance these buildings and structures in the conservation areas. All of the conservation areas, except Greenlaw are covered by legal restrictions which remove certain permitted development rights.

Inventory of Gardens and Designed Landscapes

The 'Inventory of Gardens and Designed Landscapes' are defined as 'grounds which are laid out for artistic effect'. There are two gardens and designed landscapes in Renfrewshire included in the inventory: the grounds of the former Formakin Estate and the portion of Finlaystone Estate situated in Renfrewshire.

None in CA

Scheduled monuments

There are many scheduled monuments in Renfrewshire. These include such things as prehistoric earthworks, old ruined buildings and industrial archaeology. Over 30 of them are considered to be of national importance, and have

therefore been given legal protection. These have been scheduled by the Scottish Ministers under the Ancient Monuments and Archaeological Areas Act 1979. You need Ancient Monument Consent for any works which affect a scheduled ancient monument. Advice and application forms are available from Historic Scotland.

Listed buildings

Certain buildings of special architectural or historic interest are legally protected. 'Listed' buildings are buildings which are on a list compiled or approved by the Scottish Government. Listed buildings are assigned to one of three categories by *Historic Scotland:*

> Category A - Buildings of national or international importance, either architectural or historic, or fine little-altered examples of some particular period, style or building type;
>
> Category B - Buildings of regional or more than local importance, or major examples of some period, style or building type which may have been altered; and,
>
> Category C - Buildings of local importance, lesser examples of any period, style or building type, as originally constructed or altered, and simple, traditional buildings, which group well with Categories A and B or are part of a planned group such as an estate or an industrial complex.

Renfrewshire's Category A listed buildings include both Paisley and Renfrew town halls, Coats Memorial Church, India of Inchinnan and the Weaver's Cottage in Kilbarchan. The following include Category B and Category C listed buildings within the CA:

- Paisley Abbey
- Stanley Castle
- Fountain Gardens

- *Castle Semple Loch Tower*
- *Cricket Grounds - in conservation area (GS near hospital)*
- *Paisley Town center*
- *GS near Mackie's Mill*
- *GS near Shaw Wood*
- *GS near Kilbarchan Agricultural Fields*
- *GS near Bridge of Weir*

- *GS near Thornly Park*

Sources:

http://data.historic-scotland.gov.uk/pls/htmldb/f?p=2300:30:0

http://data.historic-scotland.gov.uk/pls/htmldb/f?p=2400:15:0:::GARDEN:GDL00382

http://www.eastrenfrewshire.gov.uk/chttphandler.ashx?id=1022&p=0

Scottish Wildlife Trust reserves

None in CA or within 30km

https://data.nbn.org.uk/Datasets/GA000343=

Areas of Outstanding Natural Beauty (AONB)

None in CA or within 30 km

https://data.nbn.org.uk/imt/?boundary=GA000696#4-5.110,55.542,-3.198,56.120!4hX

Special Areas of Conservation in Great Britain

None in CA or within 30 km

https://data.nbn.org.uk/imt/?boundary=GA000327#4-4.833,55.417,-2.922,55.997!4KT

Special Protection Areas in Great Britain

None in catchment area

Nearby - Clyde Muirshiel Regional Park

Source: Joint Nature Conservation Committee

Areas of Great Landscape Value (AGLV)

None in CA

Urban Landscape Protection Area (ULPA)

None in CA

Sources:

http://www.torbay.gov.uk/torbayreviewofurbanlandscape.pdf

and

http://www.paisleynaturalhistorysociety.org.uk

11.41 These enclaves of special landscape quality set in or bordering the urban areas (some of which skirt the coastal fringe) make a considerable contribution in different ways to the environment. Some act as local vantage points, some as amenity open space and others as landmarks in the local scene; in some cases they perform all three roles. Some ULPAs are also of ecological significance.

11.42 It is important therefore that priority is given to protecting the essential landscape features of these areas to ensure that their contribution to the landscape of the urban area is protected. Whilst the policy does not necessarily preclude all developments in these locations, it will be necessary to demonstrate that the quality of these areas is retained. In appropriate cases, the Council will consider the preparation of management plans to safeguard and improve such areas.

11.43 Part of L6.6 Scotts Bridge/Barton, Torquay has been the subject of an application to the High Court under Section 287 of the Town and Country Planning Act 1990 to challenge the validity of the Adopted Local Plan. The challenge relates solely to that part of the Urban Landscape Protection Area known as 'Scotts Meadow', adjoining Riviera Way. A High Court Hearing will be held in Autumn 2004. The remainder of the Local Plan is unaffected by this challenge.

GS within Case Study Area SQ Boundary

Levels: Yes or No

Mode of Access to GS

Levels: Walk, Bike, Car, Bus, Train (Tram).

Distance to Nearest GS

Levels:
1 = "0-400 M (0-5 MIN WALK)" 2 = "400-800 M (5-10 MIN WALK)" 3 = "OVER 800 M (OVER 10 MIN WALK)" 4 = "NO HOME PROVIDED"

There are many approaches used to measure the access to green spaces found in literature, though no consensus exists. Most studies have used Geographic Information Systems (GIS) to measure accessibility (Oh and Jeong, 2007; Sister et al., 2010). Metrics include presence vs. absence of a park or recreation facility near the home, density of facilities, distance, or total park acreage within a given radius of home (Mota et al., 2005; Norman et al., 2006; Roenmich et al., 2006; Zakarian). However, measurements related to the users of green spaces and their access behaviours or actions within these green spaces have proven difficult to quantify comprehensively.

This study considered many accessibility models. The United Kingdom utilises a unique accessibility measure, Accessible Natural Greenspace Standard (ANGSt), originally developed by English Nature and Natural England, to analyse levels of provision and deficiency as well as area and distribution in order to target green space provision improvements. This strategy does not look at usability, only per-hectare measurements per population; green space quality is not measured here. Additionally, size and proximity does not include benefits being met through other smaller green spaces. (Planning Policy Guidance 17 (PPG17), Office of the Deputy Prime Minister, 2002a, b)

The methodology utilised in this non-structural characteristic analysis to assess the distance to their nearest green space was a simple, clear, physical proximity or measurable distance to nearest green space.

First, a visual assessment was completed via google earth (e.g. google maps). Each respondent had a home location geolocated whose neighbourhood area was visually analysed to find the nearest green structure. The criteria for this green structure was discretionary per the researcher, who is an expert in the field, with a goal of determining if the green structure could provide a human well-being benefit within a 'reasonable' size and structure. Significantly, the green structure had to be a destination, meaning though a row of street trees or a private garden may offer psychological benefits, it was not included. Additionally, the green structure typologies as outlined in this research helped determine the viability of a nearest green structure as a functional GS for HWB benefits.

Second, the nearest green space was noted with a geomarker and a linear distance was measured via roadways and sidewalks, not nearest path or direct-line distance. If no sidewalks could be clearly discerned, additional distance was calculated, however this was not the case in any respondents. If multiple green spaces seemed similar in distance, they were both measured to discern the closest to home green space. This information was noted for each respondent. This process identified the physical distance of the nearest green space to each respondent.

Was Nearest GS Visited (as a FGS/OGS)

Levels: Yes or No

Appendix 18 - Descriptive Analysis Results – Non-Structural Landscape Factors – Grouping 1

Paisley, Scotland C

Favourite Green Spaces Visited - FGS
113 individual FGS locations (n=113) provided by respondents.
57 Unique individual FGS locations (n=57) provided by respondents.

Highest frequency selections of FGS to visit:
15% of respondents (n=17) listed Pollock Park as FGS.
11.5% of respondents (n=13) listed Barshaw Park as FGS.
5.3% of respondents (n=6) listed Brodie Park as FGS.
5.3% of respondents (n=6) listed Glennifer Braes County Park - Robertson Park as FGS.
4.4% of respondents (n=5) listed Bellahouston Park as FGS.
4.4% of respondents (n=5) listed Clyde Murishiel Regional Park - Castle Semple Loch as FGS.

Lowest frequency selections of FGS to visit:
43 responses (n=43) were a FGS with only a frequency of 0.9% (n=1).

FGS with a Title or Name:
85% of responses (n=97) were a FGS that included a Name or a Title to it.

FGS Located within provided Catchment Area (Y/N)
68.1% of FGS markers (n=77) are within Catchment Area
31.9% of FGS markers (n=36) are not within Catchment Area

FGS Typological Definition (15 GS typologies)
55.8% of FGS markers (n=63) are a Park Typology
2.5% of FGS markers (n=11) are a Water and Wetland Typology
2.3% of FGS markers (n=10) are a Outdoor Sports Facility Typology
1.8% of FGS markers (n=8) are a Woodland Typology
1.8% of FGS markers (n=8) are a Green Corridor Typology
1.6% of FGS markers (n=7) are a Other Natural or SemiNatural GS Typology
0.7% of FGS markers (n=3) are an Agricultural Typology
0.2% of FGS markers (n=1) are a Children's Play Area Typology
0.2% of FGS markers (n=1) are a Civic Space Typology
0.2% of FGS markers (n=1) are an Other Green Space Typology

0.0% of FGS markers (n=0) are a Cemetery and Churchyard Typology
0.0% of FGS markers (n=0) are a Community Garden and Allotment Typology
0.0% of FGS markers (n=0) are a Grassland Typology
0.0% of FGS markers (n=0) are an Amenity Green Space Typology
0.0% of FGS markers (n=0) are a Garden and Grounds Typology

FGS Ownership (Public, Private, Unknown)
88.5% of FGS markers (n=100) are in Public Ownership
7.1% of FGS markers (n=8) are in Private Ownership
1.1% of FGS markers (n=5) are in Unknown Ownership

FGS Special Land Use Designation (Y/N)
41.6% of FGS markers (n=47) have a Special Designation to them
57.5% of FGS markers (n=65) do not have a Special Designation to them
0.9% of FGS markers (n=1) are in Unknown Special Designation to them

Distance to FGS (m)
6.8% of respondents (n=10) listed a FGS with a 0-5 minute walk
8.2% of respondents (n=12) listed a FGS with a 5 -10 minute walk
15.6% of respondents (n=23) listed a FGS with over a 10 minute walk
25.2% of respondents (n=37) listed a FGS with Mod vehicular ride
44.2% of respondents (n=65) listed a FGS with Long vehicular ride

Mode of Access to FGS (walk, bike, car, bus, train)
38.7% of respondents (n=43) listed a FGS accessed by Walking
8.1% of respondents (n=9) listed a FGS accessed by Bike
50.5% of respondents (n=56) listed a FGS accessed by Car
2.7% of respondents (n=3) listed a FGS accessed by Bus
0% of respondents (n=0) listed a FGS accessed by Train

FGS Issues or Problems & FGS Improvement Ideas
Full results located in Appendix 23

Question 1 - Are there any specific issues or problems at this Green Space?
Responses received (n=41), the most frequent noted below:
'no' n=10
'more bins' n=3

Question 2 - Do you have any ideas for improvements to this Green Space?
Responses received (n=32), the most frequent noted below
'no' n=5
'dogs' and various issues with dog conflict, dog mess, too many dogs n=5
'litter' an dother issues of trash n=4

Other Green Spaces Visited - OGS
69 individual OGS locations (n=69) provided by respondents.
49 Unique individual OGS locations (n=49) provided by respondents

Highest frequency selections of OGS to visit:
5.8% of respondents (n=4) listed Bellahouston Park as OGS.
5.8% of respondents (n=4) listed Glennifer Braes County Park - Robertson Park as OGS.

5.8% of respondents (n=4) listed Brodie Park as OGS.
4.3% of respondents (n=3) listed Rouken Glen Park as OGS.
4.3% of respondents (n=3) listed Barshaw Park as OGS.

0% of respondents (n=0) listed Clyde Murishiel Regional Park - Castle Semple Loch as OGS.

Lowest frequency selections of OGS to visit:
37 responses (n=37) were a GS with only a frequency of 1.4% (n=1).

OGS Located within provided Catchment Area (Y/N)
62.3% of OGS markers (n=43) are within Catchment Area
37.7% of OGS markers (n=26) are not within Catchment Area

OGS Typological Definition(15 GS typologies)
53.6% of OGS markers (n=37) are a Park Typology
10.1% of OGS markers (n=7) are a Outdoor Sports Facility Typology
8.7% of OGS markers (n=6) are a Other Natural or SemiNatural GS Typology
7.2% of OGS markers (n=5) are an Agricultural Typology
5.8% of OGS markers (n=4) are a Grassland Typology
4.3% of OGS markers (n=3) are a Green Corridor Typology
2.9% of OGS markers (n=2) are a Garden and Grounds Typology
2.9% of OGS markers (n=2) are an Amenity Green Space Typology
1.4% of OGS markers (n=1) are a Cemetery and Churchyard Typology
1.4% of OGS markers (n=1) are a Water and Wetland Typology
1.4% of OGS markers (n=1) are an Other Green Space Typology

0.0% of OGS markers (n=0) are a Woodland Typology
0.0% of OGS markers (n=0) are a Children's Play Area Typology
0.0% of OGS markers (n=0) are a Civic Space Typology
0.0% of OGS markers (n=0) are a Community Garden and Allotment Typology

OGS Ownership (Public, Private, Unknown)
71.0% of OGS markers (n=49) are in Public Ownership
11.6% of OGS markers (n=8) are in Private Ownership
17.5% of OGS markers (n=12) are in Unknown Ownership

OGS Special Land Use Designation (Y/N)
33.3% of OGS markers (n=23) have a Special Designation to them
66.7% of OGS markers (n=46) do not have a Special Designation to them
0.0% of OGS markers (n=0) are in Unknown Special Designation to them

Distance to OGS (m)
4.3% of respondents (n=3) listed a OGS with a 0-5 minute walk
5.8% of respondents (n=4) listed a OGS with a 5 -10 minute walk
13.0% of respondents (n=9) listed a OGS with over a 10 minute walk
36.2% of respondents (n=25) listed a OGS with Mod vehicular ride

40.6% of respondents (n=28) listed a OGS with Long vehicular ride

Mode of Access to OGS (walk, bike, car, bus, train)
This was not asked for the OGS.

Paisley, Scotland CA

Favourite Green Spaces Visited - FGS
113 individual FGS locations (n=113) provided by respondents.
57 unique individual FGS locations (n=57) provided by respondents.

Table A18.1
FGS Geomarkers Effective Samples – Paisley CA

15% of respondents (n=17) listed Pollock Park as FGS.
11.5% of respondents (n=13) listed Barshaw Park as FGS.
5.3% of respondents (n=6) listed Brodie Park as FGS.
5.3% of respondents (n=6) listed Glennifer Braes County Park - Robertson Park as FGS.
4.4% of respondents (n=5) listed Bellahouston Park as FGS.
4.4% of respondents (n=5) listed Clyde Murishiel Regional Park - Castle Semple Loch as FGS.

Table A18.2
Highest 6 Named FGS Geomarkers Frequencies – Paisley CA

100% of these six FGS are Titled GS.
100% are Public GS.
50% have a Special Designation to them.
83.3% are Park Typologies (1=Water).
66.6% are within the Catchment Area

Table x.x
Highest 6 Named FGS Geomarkers Frequency Summary– Paisley CA
(See Appendix 31 for Full Results)

The Figures and Tables below shows the Paisley, CA FGS locations and expressed as a heat map.

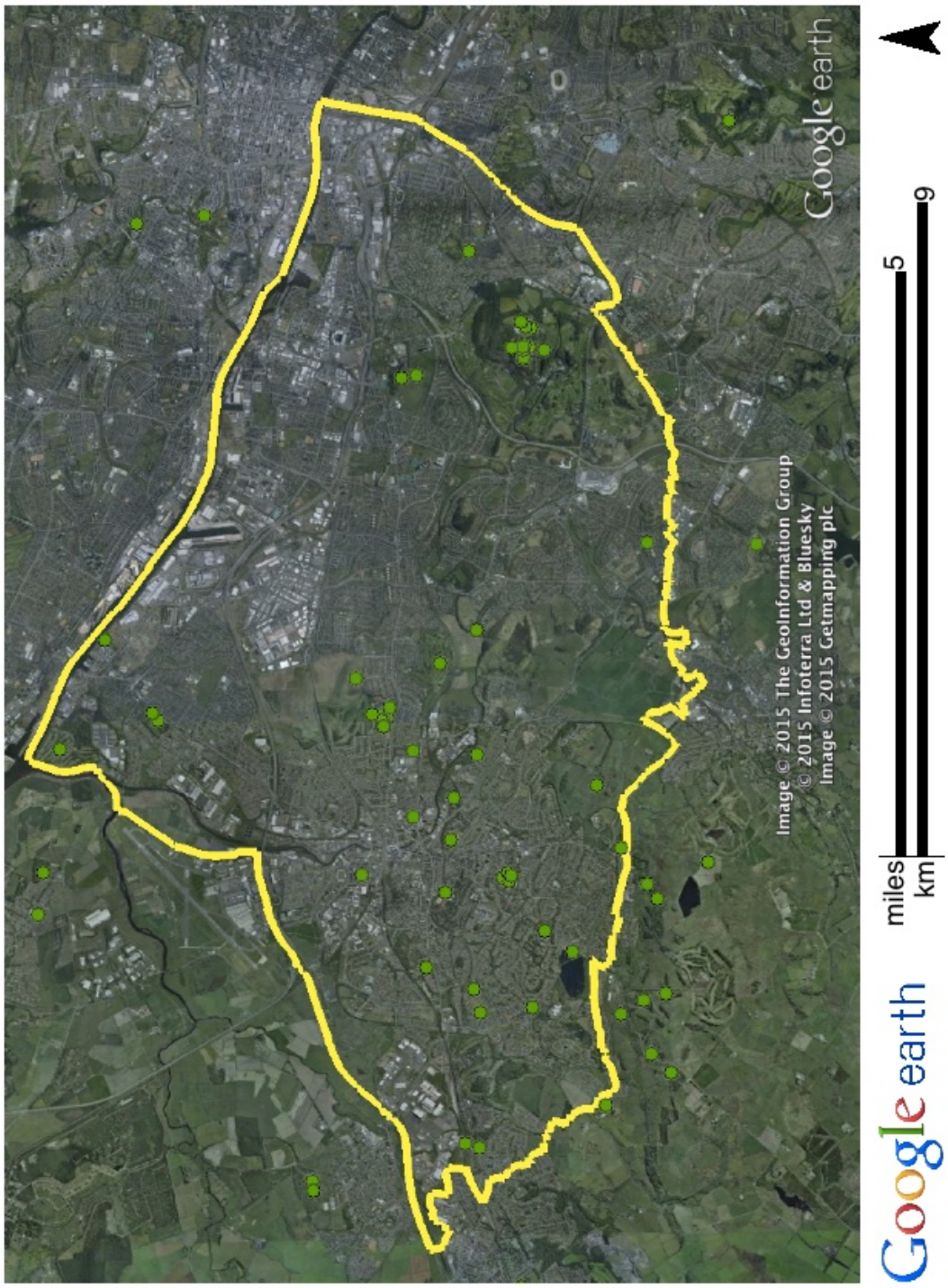


Figure A18.1
FGS Locations – Paisley CA

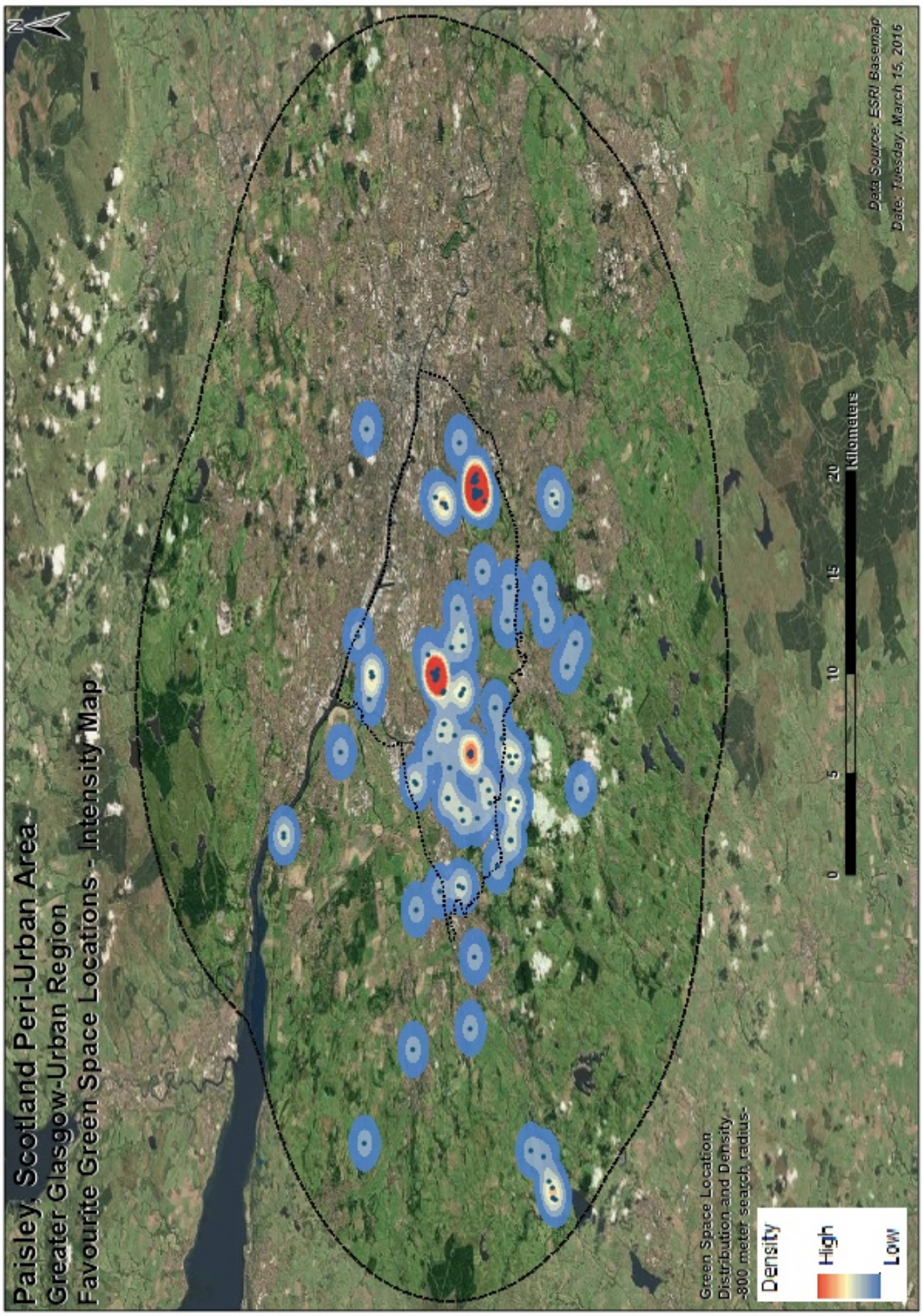


Figure A18.2
FGS Locations Heat Map – Paisley CA

Other Green Spaces Visited - OGS
69 individual OGS locations (n=69) provided by respondents.
49 unique individual OGS locations (n=49) provided by respondents

Table A18.3
OGS Geomarkers Effective Samples – Paisley CA

5.8% of respondents (n=4) listed Bellahouston Park as OGS.
5.8% of respondents (n=4) listed Glennifer Braes County Park - Robertson Park as OGS.
5.8% of respondents (n=4) listed Brodie Park as OGS.
4.3% of respondents (n=3) listed Rouken Glen Park as OGS.
4.3% of respondents (n=3) listed Barshaw Park as OGS.

Table A18.4
Highest 5 Named OGS Geomarkers Frequencies – Paisley CA

100% of these five OGS are Titled GS.
100% are public GS
40% have a Special Designation to them
100% are Park Typologies
60% are within the Catchment Area.

Table A18.5
Highest 5 Named OGS Geomarkers Frequency Summary– Paisley CA
(See Appendix 31 for Full Results)

The Figures and Tables below shows the Paisley, CA OGS locations and expressed as a heat map.

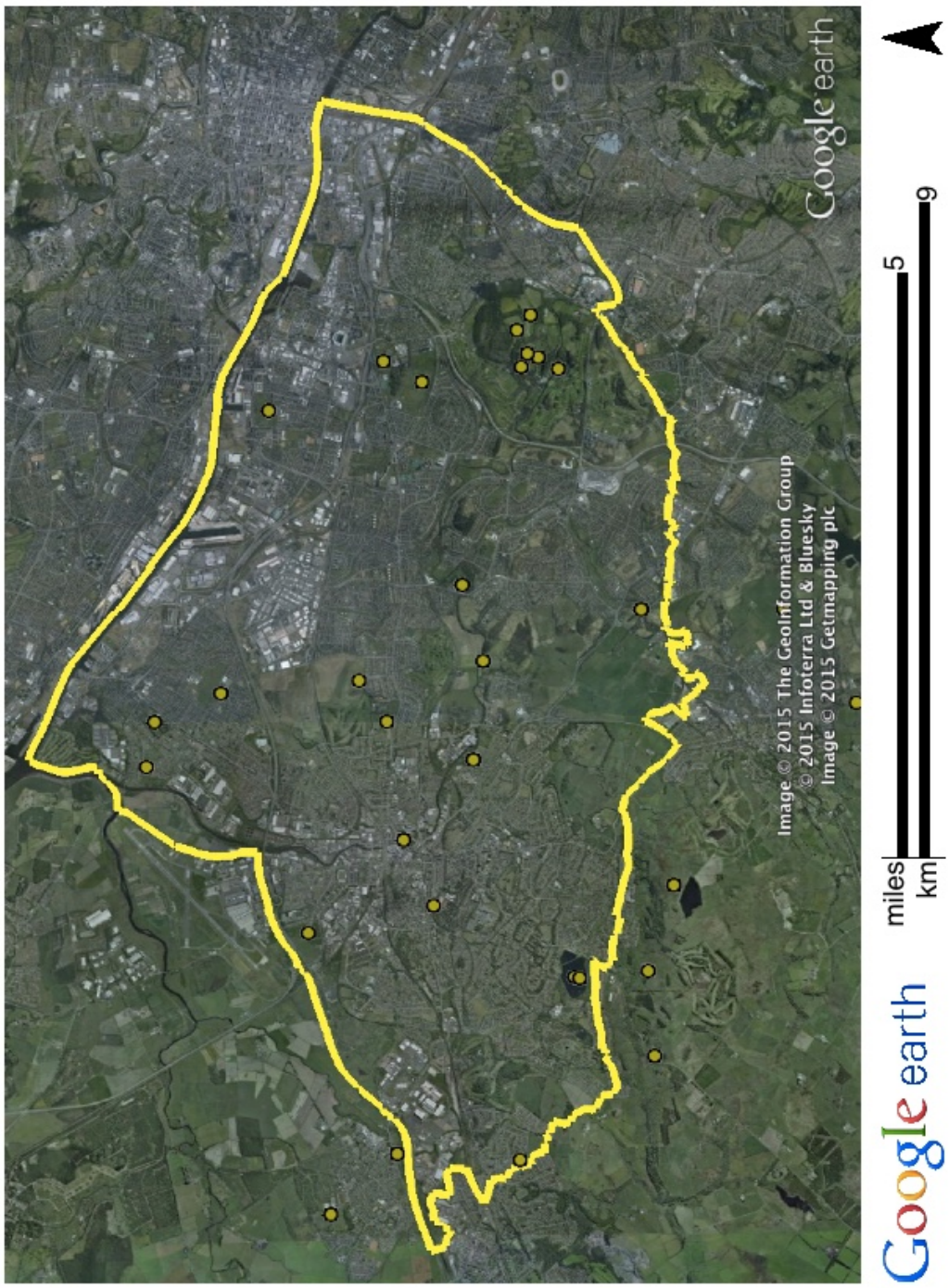


Figure A18.3
OGS Locations – Paisley CA

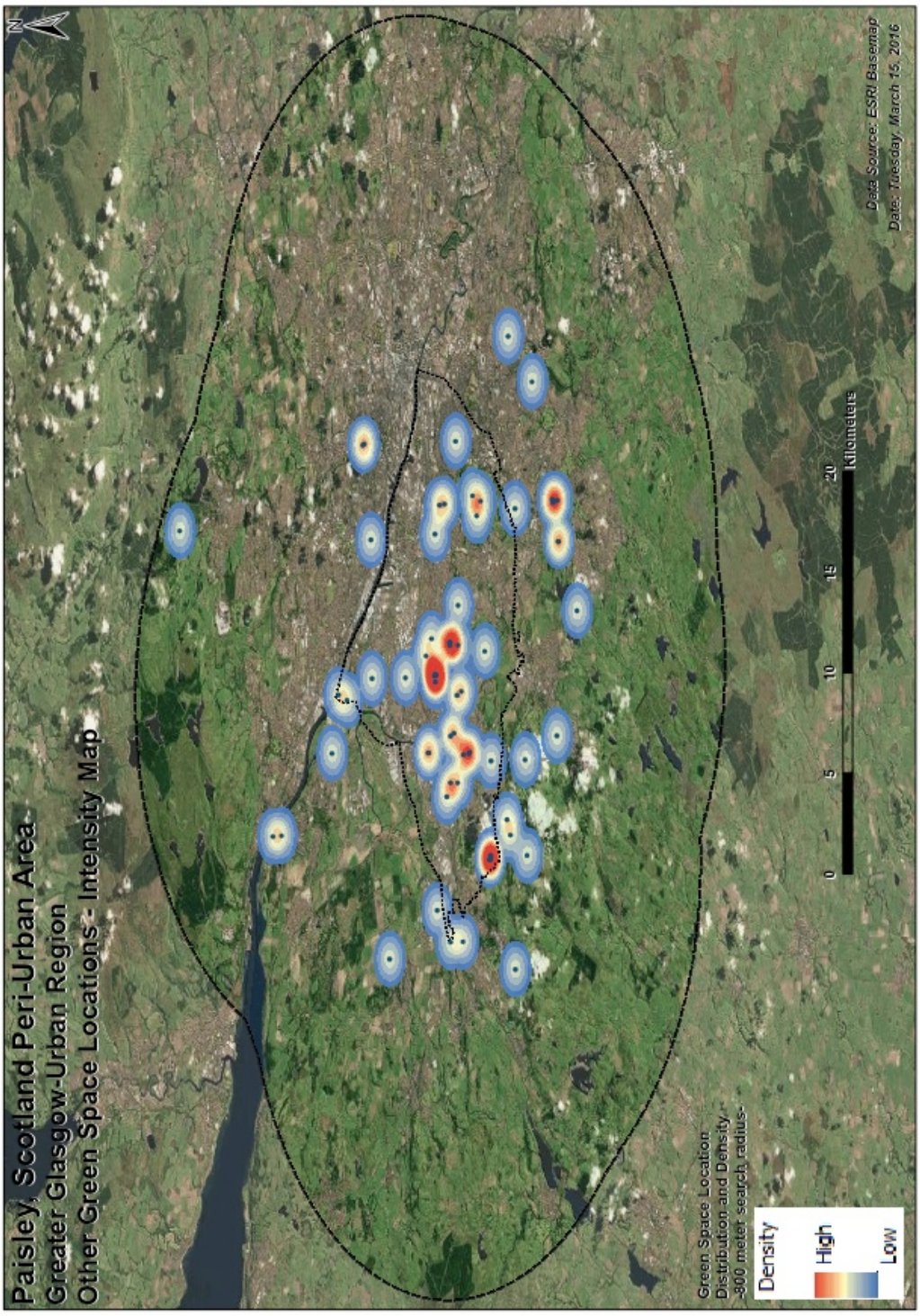


Figure A18.4
OGS Locations Heat Map – Paisley CA

Paisley, Scotland Descriptive Analysis Summary of Findings

Paisley, Scotland CA FGS Non-Structural Characteristics

Of the total 88 possible FGS choices provided by respondents, 43 or 48.3% were a singular marker and not shared by other respondents. This indicates respondents select uniquely when it comes to GS visitation.

Overall, 85.8% (n=97) of the total 113 FGS location markers were named FGS. This potentially indicates a level of comfort, safety and familiarity when selecting GS to visit. Additionally, 88.5% of FGS markers (n=100) were a publically owned FGS. Results also suggest, generally, people who live in the Paisley CA, though they are willing to travel long distances to get to a FGS, ⅔ are found within the 789,844,910 sq/m catchment area. Car was the most utilised form of access to visit these FGS. Yet, walking was a close second followed by bike at 8.1%. This result suggests, generally, people in the Paisley CA, though they are willing to travel long distances to get to FGS, they will NOT utilise public transportation such as train and bus.

Paisley, Scotland CA OGS Non-Structural Characteristics

Of the total 49 selected OGS provided by the respondents, 37 or 75.5% were a singular marker and not shared by other respondents**.** This indicates respondents select uniquely when it comes to GS visitation.

Overall, 73.9% (n=51) of the total 69 OGS location markers were named OGS. This potentially indicates a level of comfort, safety and familiarity when selecting a GS to visit. Results suggests, generally, people who live in the Paisley Metropolitan Region, though they are willing to travel long distances to get to a OGS, almost ⅔ are found within the 789,844,910 sq/m catchment area.

Vantaa, Finland Descriptive Analysis Results

Favourite Green Spaces Visited - FGS

145 individual FGS locations (n=145) provided by respondents
112 Unique individual FGS locations (n=112) provided by respondents

Highest frequency selections of FGS to visit:

11.4% of respondents (n=28) listed Lamasaari Island as FGS.
6.1% of respondents (n=15) listed Paloheina Woodlands as FGS.
3.7% of respondents (n=9) listed Fastholma Green Space as FGS.
2.4% of respondents (n=6) listed the following as FGS:

Kivinnoka GS, Uutela Recreation Area, Vantaa River near Silvola

Lowest frequency selections of FGS to visit:
101 responses (n=101) were a FGS with only a frequency of 0.8% (n=1).

FGS Located within provided Catchment Area (Y/N)
71% of FGS markers (n=103) are within Catchment Area
29% of FGS markers (n=42) are not within Catchment Area

FGS Typological Definition (15 GS typologies)
35% of FGS markers (n=51) are a Woodland Typology
14% of FGS markers (n=20) are a Other Natural or SemiNatural GS Typology
12% of FGS markers (n=18) are a Park Typology
10% of FGS markers (n=15) are a Green Corridor Typology
7% of FGS markers (n=10) are an Amenity Green Space Typology
7% of FGS markers (n=10) are a Water and including Coastal Land Typology
3.7% of FGS markers (n=4) are a Community Garden, Allotment & City Farm Typology
3.2% of FGS markers (n=3) are an Agricultural Typology
2% of FGS markers (n=2) are a Outdoor Sports Facility Typology
2% of FGS markers (n=2) are an Other Green Space Typology
1% of FGS markers (n=1) are a Children's Play Area Typology
1% of FGS markers (n=1) are a Grassland Typology

0.0% of FGS markers (n=0) are a Civic Space Typology
0.0% of FGS markers (n=0) are a Cemetery and Churchyard Typology
0.0% of FGS markers (n=0) are a Garden and Grounds Typology

FGS Ownership (Public, Private, Unknown)
67 % of FGS markers (n=97) are in Public Ownership
0% of FGS markers (n=0) are in Private Ownership
33% of FGS markers (n=48) are in Unknown Ownership

FGS Special Land Use Designation (Y/N)
80% of FGS markers (n=115) have a Special Designation to them
20% of FGS markers (n=30) do not have a Special Designation to them
0% of FGS markers (n=0) are in Unknown Special Designation to them

Distance to FGS (m)
11% of respondents (n=16) had a FGS with a 0-5 minute walk listed as FGS.
7.6% of respondents (n=11) had a FGS with a 5 -10 minute walk listed as FGS.
13.1% of respondents (n=19) had a FGS with over a 10 minute walk listed as FGS.
21.4% of respondents (n=31) had a FGS with Mod vehicular ride listed as FGS.
46.9% of respondents (n=68) had a FGS with Long vehicular ride listed as FGS.

Mode of Access to FGS (walk, bike, car, bus, train)

51 % of respondents (n=74) listed a FGS accessed by Walking
30 % of respondents (n=44) listed a FGS accessed by Bike
11% of respondents (n=16) listed a FGS accessed by Car
7% of respondents (n=10) listed a FGS accessed by Bus
1% of respondents (n=1) listed a FGS accessed by Train
0% of respondents (n=0) listed a FGS accessed by Tram

FGS Issues or Problems & FGS Improvement Ideas
Question 1 - Are there any specific issues or problems at this Green Space?
Responses received (n=41), the most frequent noted below
'no' n=3
'path maintenance n=3

Question 2 - Do you have any ideas for improvements to this Green Space?
Responses received (n=23), the most frequent noted below
'no' n=3
'benches' and 'seating' n=3
'litter' an other issues of trash, bins n=2

Other Green Spaces Visited - OGS
102 individual OGS locations (n=102) provided by respondents
75 Unique individual GS locations (n=75) provided by respondents
n=102

Highest frequency selections of OGS to visit:
10% of respondents (n=10) listed Lamasaari Island as OGS.
10% of respondents (n=10) listed Paloheina Woodlands as OGS.
3% of respondents (n=3) listed Fastholma Green Space as OGS.

Lowest frequency selections of OGS to visit:
75 responses (n=75) were a GS with only a frequency of 1% (n=1).

OGS Located within provided Catchment Area (Y/N)
67% of OGS markers (n=68) are within Catchment Area
33% of OGS markers (n=34) are not within Catchment Area

OGS Typological Definition(15 GS typologies)
40% of OGS markers (n=41) are a Woodland Typology
13% of OGS markers (n=13) are a Park Typology
12% of OGS markers (n=12) are a Green Corridor Typology
11% of OGS markers (n=11) are a Other Natural or SemiNatural GS Typology
5% of OGS markers (n=5) are a Garden and Grounds Typology
3% of OGS markers (n=3) are an Other Green Space Typology
2% of OGS markers (n=2) are a Outdoor Sports Facility Typology
2% of OGS markers (n=2) are a Water and Wetland Typology
2% of OGS markers (n=2) are a Children's Play Area Typology

2% of OGS markers (n=1) are a Community Garden and Allotment Typology
1% of OGS markers (n=1) are a Cemetery and Churchyard Typology
0% of OGS markers (n=0) are an Amenity Green Space Typology
0% of OGS markers (n=0) are a Civic Space Typology

OGS Ownership (Public, Private, Unknown)
70% of OGS markers (n=71) are in Public Ownership
0% of OGS markers (n=0) are in Private Ownership
30% of OGS markers (n=31) are in Unknown Ownership

OGS Special Land Use Designation (Y/N)
87% of OGS markers (n=88) have a Special Designation to them
13% of OGS markers (n=46) do not have a Special Designation to them
0% of OGS markers (n=0) are in Unknown Special Designation to them

Distance to OGS (m)
6.9% of respondents (n=7) had a OGS with a 0-5 minute walk listed as OGS.
5.9% of respondents (n=6) had a OGS with a 5 -10 minute walk listed as OGS.
15.8% of respondents (n=16) had a OGS with over a 10 minute walk listed as OGS.
30.7% of respondents (n=31) had had a OGS with Mod vehicular ride listed as OGS.
40.6% of respondents (n=41) had a OGS with Long vehicular ride listed as OGS.

Mode of Access to OGS (walk, bike, car, bus, train)
This was not asked for the OGS.

Favourite Green Spaces Visited - FGS
145 individual FGS locations (n=145) provided by respondents
112 unique individual FGS locations (n=112) provided by respondents

Table A18.6
FGS Geomarkers Effective Samples – Vantaa CA

11.4% of respondents (n=28) listed Lamasaari Island as FGS.
6.1% of respondents (n=15) listed Paloheina Woodlands as FGS.
3.7% of respondents (n=9) listed Fastholma Green Space as FGS.
2.4% of respondents (n=6) listed the following as FGS:
Kivinnoka GS, Uutela Recreation Area, Vantaa River near Silvola

Table A18.7
Highest 6 Named FGS Geomarkers Frequencies – Vantaa CA

50% of these six FGS are Titled GS.
100% are Public GS.
50% are Woodland Typologies (1=Park, 1= Green Corridor, 1=Park).
83.3% are within the Catchment Area. (The only/other FGS not in the catchment area is one of the largest GS in the region)

Highest 6 Named FGS Geomarkers Frequency Summary– Vantaa CA
(See Appendix 31 for Full Results)

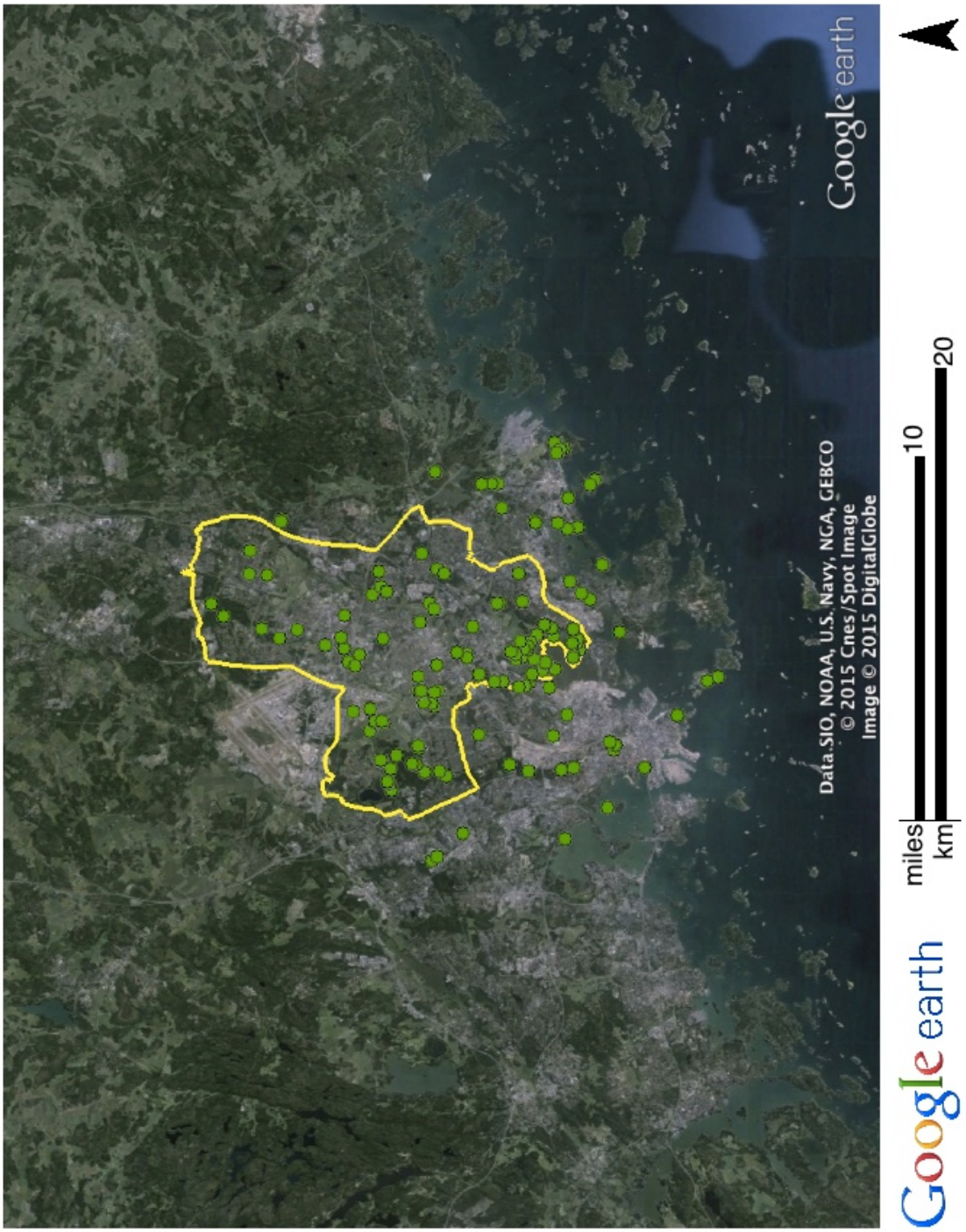


Figure A18.5
FGS Locations – Vantaa CA

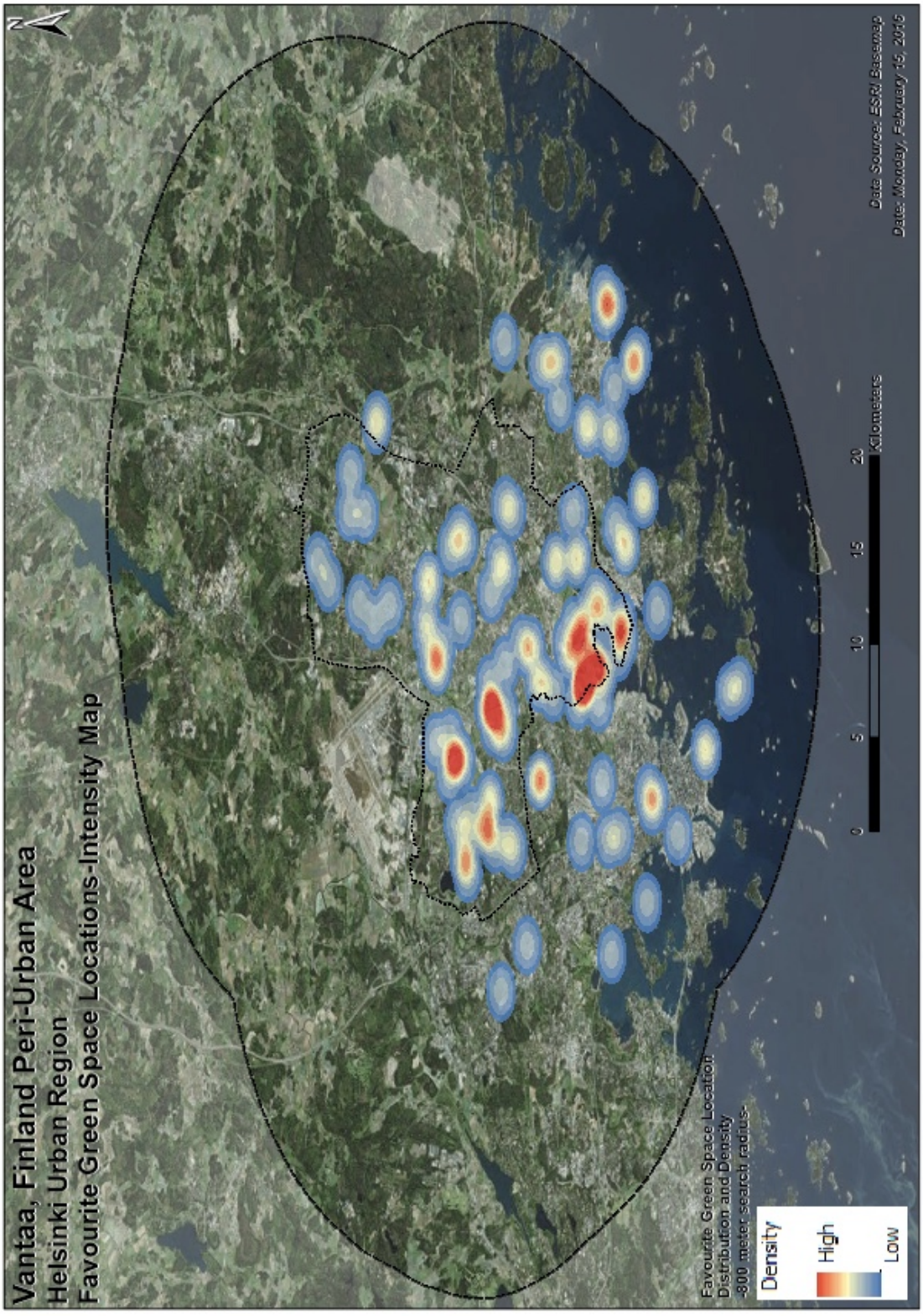


Figure A18.6
FGS Locations Heat Map – Vantaa CA

Other Green Spaces Visited - OGS
102 individual OGS locations (n=102) provided by respondents
75 unique individual GS locations (n=75) provided by respondents

Table A18.8
OGS Geomarkers Effective Samples – Vantaa CA

10% of respondents (n=10) listed Lamasaari Island as OGS.
10% of respondents (n=10) listed Paloheina Woodlands as OGS.
3% of respondents (n=3) listed Fastholma Green Space as OGS.

Table A18.9
Highest 3 Named OGS Geomarkers Frequencies – Vantaa CA

33% of these three OGS are Titled GS.
100% are Public GS
100% have a Special Designation to them
67% are Woodland Typologies
100% are within the Catchment Area.

Table A18.10
Highest 3 Named OGS Geomarkers Frequency Summary– Vantaa CA
(See Appendix 31 for Full Results)

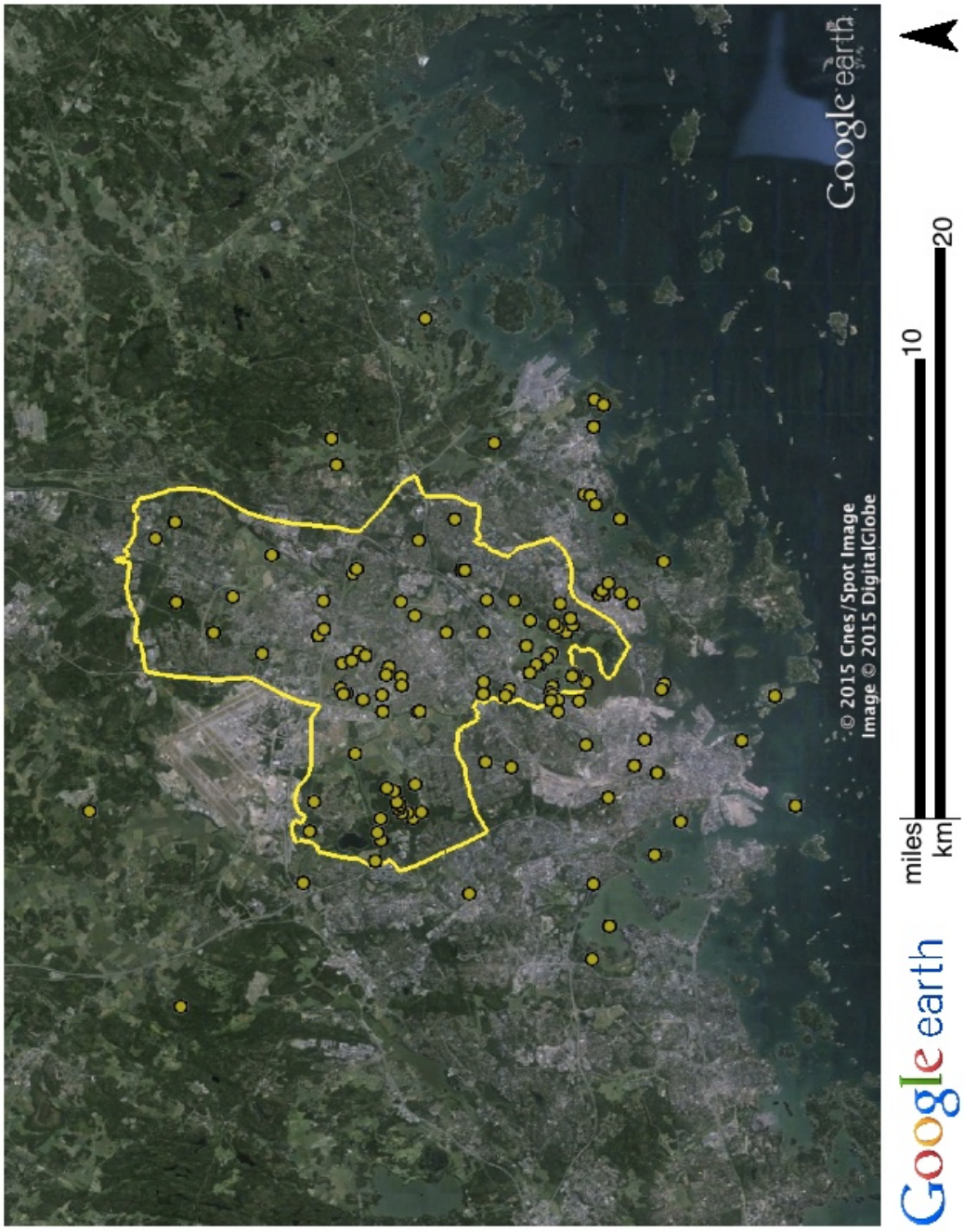


Figure A18.7
OGS Locations – Vantaa CA

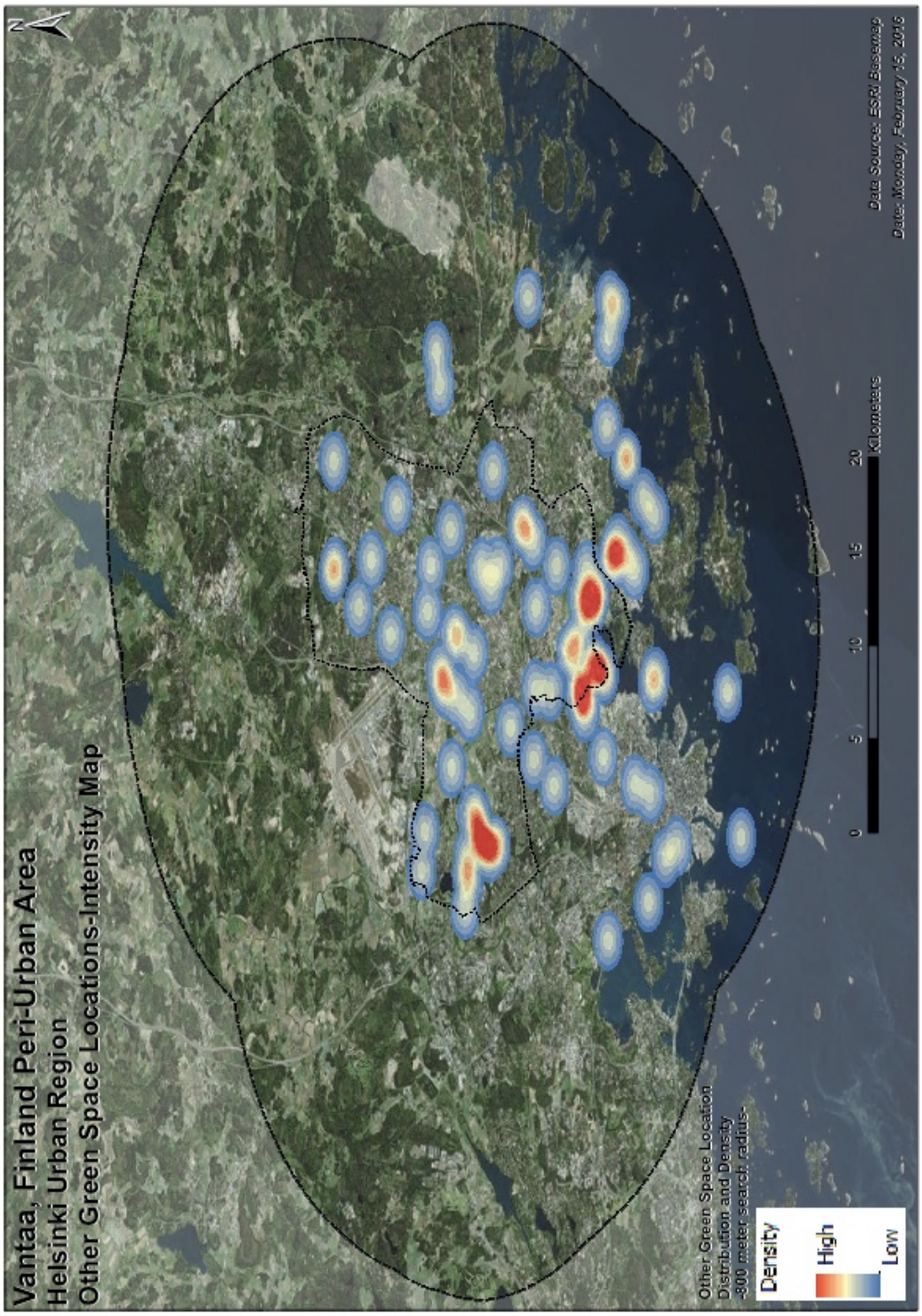


Figure A18.8
OGS Locations Heat Map – Vantaa CA

Vantaa, Finland Descriptive Analysis Summary of Findings
Vantaa, Finland CA FGS Non-Structural Characteristics

Of the total 112 possible FGS choices provided by respondents, 101 or 90% were a singular marker and not shared by other respondents. This indicates respondents select uniquely when it comes to FGS visitation. Overall, 47% (n=53) of

the total 112 FGS location markers were named GS. This potentially indicates a level of comfort, safety and familiarity when selecting GS to visit.

These results suggest, generally, people who live in the Vantaa Urban Region, though they are willing to travel long distances to get to a FGS, almost ¾ are found within the 974,577,373 sq/m catchment area. Additionally, generally, people who live in the Vantaa Urban Region, will visit certain types of FGS in order to achieve their affordance goals – here, predominately woodland and natural or semi-natural based GS typologies. This result does not tell if there is a high frequency, overall of woodland typology GS within the region, only which respondents visit.

Results also suggest, generally, people who live in the Vantaa Urban Region, will visit specially designated types of FGS, however this data states nothing of the type of special designation. This result suggests, generally, people in the Vantaa Urban Region, though they are willing to travel long distances to get to FGS, they will still walk or use a bike as the primary modes of transportation.

This data is interesting, as 47% of respondents reported they visit a FGS which was over 5k distance, 81% of respondents state they visit their FGS's through walking and biking. This data suggests physically fit and active respondents or a lack of transportation access to their FGS.

Vantaa, Finland CA OGS Non-Structural Characteristics

Of the total 102 selected OGS provided by the respondents, 75 or 74.5% were a singular marker and not shared by other respondents**.** This indicates respondents select uniquely when it comes to OGS visitation.

Also, generally, people who live in the Vantaa CA almost ⅔ of the OGS they visit are found within the 974,577,373 sq/m catchment area, and generally, people in the Vantaa CA are willing to travel long distances to get to their OGS. Additionally, generally, people who live in the Vantaa CA, will visit certain types of OGS in order to achieve their affordance goals – here, predominately woodland GS typologies.\

Appendix 19 - Descriptive Analysis Results –Structural Landscape Factors

The following tables only show those highest frequency PPUIGS characteristics fore each landscape factor.

Paisley CA
Favourite Green Spaces – FGS
≤ 113 individual FGS locations (n=113) provided by respondents

Size Characteristics
73%% of respondents (n=79) selected an Extensive GS which separate houses and structures well so you do not see houses when in the FGS.
72% of respondents (n=81) selected a High Density GS from which you can see another GS when in the FGS.
52% of respondents (n=55) selected a Moderately Sized GS from which you can see as a FGS.

Shape Characteristics
44% of respondents (n=49) selected a Natural GS as a FGS.
46% of respondents (n=51) selected a Regularly Shaped GS with mostly evenly-spaced and/or evenly-lengthed sides (rectangle, square, or mostly equilateral polygon) as a FGS.
44% of respondents (n=49) selected a Simply Shaped GS which is uniform in shape (3-4 sides). as a FGS.

Proximity Characteristics
76%% of respondents (n=96) selected a Connected GS which is considered one in a group of GS as a FGS.
61% of respondents (n=68) selected a Grouped GS from which you can see another GS when in the FGS.
54% of respondents (n=52) selected an Integrated GS which is part of a larger GS as a FGS.

Edge Characteristics
41%% of respondents (n=42) selected a Numerously Edged GS with 8 or more edges as a FGS.
61% of respondents (n=63) selected a Moderately Lengthed Edged GS when compared to other GS within the CA as a FGS.
34% of respondents (n=38) selected a Moderately Dense Edge GS where some edge areas offer visibility into the FGS.

Level of Greenness Characteristics
55%% of respondents (n=61) selected a primarily Deciduously Vegetated GS as a FGS.
44% of respondents (n=50) selected a Semi-Natural GS as a FGS.
45% of respondents (n=50) selected a Uniform Distribution of Horizontally Vegetated GS as a FGS.

46% of respondents (n=51) selected a Clustered Distribution of Vertically Vegetated GS as a FGS.
41% of respondents (n=46) selected a Densely Vegetated GS as a FGS.
53% of respondents (n=60) selected a GS located Close or directly adjacent to a heavy trafficked road as a FGS.
56% of respondents (n=63) selected a GS with many (3+) Extensive and long views when located within the GS as a FGS.

Other Green Spaces – OGS

≤ 69 individual OGS locations (n=69) provided by respondents

Size Characteristics
66%% of respondents (n=43) selected an Extensive GS which separate houses and structures well so you do not see houses when in the OGS.
64% of respondents (n=44) selected a High Density GS from which you can see another GS when in the OGS.
46% of respondents (n=31) selected a Moderately Sized GS from which you can see as an OGS.

Shape Characteristics
37% of respondents (n=25) selected an Urban GS as an OGS.
45% of respondents (n=27) selected a Regularly Shaped GS with mostly evenly-spaced and/or evenly-lengthed sides (rectangle, square, or mostly equilateral polygon) as an OGS.
40% of respondents (n=25) selected a Simply Shaped GS which is uniform in shape (3-4 sides) as an OGS.

Proximity Characteristics
61% of respondents (n=42) selected a Connected GS which is considered one in a group of GS as an OGS.
50% of respondents (n=34) selected a Grouped GS from which you can see another GS when in the OGS.
57% of respondents (n=37) selected an Autonomous GS which is not physically part of another GS as an OGS.

Edge Characteristics
42% of respondents (n=22) selected a Moderately Edged GS with 4 -8 edges as an OGS.
81% of respondents (n=46) selected a Moderately Lengthed Edged GS when compared to other GS within the CA as an OGS.
46% of respondents (n=31) selected a Moderately Dense Edge GS where some edge areas offer visibility into the OGS.

Level of Greenness Characteristics
45%% of respondents (n=31) selected a primarily Deciduously Vegetated GS as an OGS.
48% of respondents (n=33) selected a Semi-Natural GS as an OGS..
61% of respondents (n=42) selected a Uniform Distribution of Horizontally Vegetated GS as an OGS.

51% of respondents (n=35) selected a Clustered Distribution of Vertically Vegetated GS as an OGS.
46% of respondents (n=36) selected a Openly Vegetated GS as an OGS.
41% of respondents (n=28) selected a GS located Close or directly adjacent to a heavy trafficked road as an OGS.
45% of respondents (n=31) selected a GS with a Moderate amount (1-3) of Extensive and long views as well as some limited view areas when located within the GS as an OGS.

Overall, very few (n=6) eco-spatial structural characteristics changed between the Paisley sample's FGS and OGS. Whereas size was the only characteristic to remain consistent, the following changes were reported:

(Shape)	Natural levels of greenness in FGS, but urban levels of greenness in OGS and GS
(Proximity)	Integrated levels of coherence in FGS and GS but autonomous OGS
(Edge)	Numerous levels of edges in FGS and GS but moderate edges in OGS
(Lvl Green)	Dense levels of vegetation structure in FGS but open levels in OGS and GS
(Lvl Green)	Extensive levels of views within FGS and GS but moderate in OGS
(Mnt/Mgmt)	Cleanliness levels within FGS and GS but moderate in OGS
(Mnt/Mgmt)	Mixed path levels within FGS but paved in OGS and GS

Table x.xx
GS Characteristic Comparison Summary – Paisley CA

These results indicate that the Edge FGS characteristics are more fragmented than the Edge characteristics for those OGS visited.

Vantaa CA
Favourite Green Spaces – FGS
≤ 145 individual FGS locations (n=145) provided by respondents

Size Characteristics
60% of respondents (n=87) selected an Extensive GS which separate houses and structures well so you do not see houses when in the FGS.
50% of respondents (n=72) selected a Moderate Density GS from which you can see another GS at a distance when in the FGS.
38% of respondents (n=55) selected a Moderately Sized GS from which you can see as a FGS.

Shape Characteristics
64% of respondents (n=92) selected a Natural GS as a FGS.
42% of respondents (n=61) selected an Irregularly Shaped GS with many uniquely-angled corners and very few if any similarly-spaced or similarly-lengthed sides as a FGS.

36% of respondents (n=52) selected a Moderately Complex Shaped GS which is somewhat regular in shape (4-8 sides) as a FGS.

Proximity Characteristics
80% of respondents (n=116) selected a Connected GS which is considered one in a group of GS as a FGS.
79% of respondents (n=115) selected a Grouped GS from which you can see another GS when in the FGS.
83% of respondents (n=121) selected an Integrated GS which is part of a larger GS as a FGS.

Edge Characteristics
39% of respondents (n=57) selected a Numerously Edged GS with 8 or more edges as a FGS.
40% of respondents (n=58) selected a Moderately Lengthed Edged GS when compared to other GS within the CA as a FGS.
41% of respondents (n=59) selected a Densely Edged GS where edge areas block most visibility into the FGS

Level of Greenness Characteristics
88% of respondents (n=128) selected a primarily Mixed Vegetated GS as a FGS.
50% of respondents (n=72) selected a Natural GS as a FGS.
48% of respondents (n=69) selected a Uniform Distribution of Horizontally Vegetated GS as a FGS.
56% of respondents (n=73) selected a Diverse and Random Vertically Vegetated GS as a FGS.
43% of respondents (n=62) selected a Densely Vegetated GS as a FGS.
42% of respondents (n=61) selected a GS located Close or directly adjacent to a heavy trafficked road as a FGS.
42% of respondents (n=61) selected a GS with a few (1-3) extensive views, some areas with limited visibility, when located within the GS as a FGS.

Other Green Spaces – OGS

≤ 102 individual OGS locations (n=102) provided by respondents

Size Characteristics
66%% of respondents (n=65) selected an Extensive GS which separate houses and structures well so you do not see houses when in the OGS.
51% of respondents (n=39) selected a High Density GS from which you can see another GS when in the OGS.
40% of respondents (n=40) selected a Moderately Sized GS from which you can see as an OGS.

Shape Characteristics
37% of respondents (n=25) selected a Natural GS as an OGS.
40% of respondents (n=40) selected an Irregularly Shaped GS with mostly evenly-spaced and/or evenly-lengthed sides (rectangle, square, or mostly equilateral polygon) as an OGS.

40% of respondents (n=25) selected a Moderately Complex Shaped GS which is neither complex nor simple in shape (4-8 sides) as an OGS.

Proximity Characteristics

83% of respondents (n=84) selected a Connected GS which is considered one in a group of GS as an OGS.

74% of respondents (n=74) selected a Grouped GS from which you can see another GS when in the OGS.

68% of respondents (n=69) selected an Integrated GS which is not physically part of another GS as an OGS.

Edge Characteristics

38% of respondents (n=38) selected a Numerously Edged GS with 4 -8 edges as an OGS.

39% of respondents (n=39) selected a Moderately Lengthed Edged GS when compared to other GS within the CA as an OGS.

41% of respondents (n=41) selected a Dense Edge GS where some edge areas block visibility into the OGS.

Level of Greenness Characteristics

82% of respondents (n=11) selected a Mixed Vegetated GS as an OGS.

43% of respondents (n=43) selected a Natural GS as an OGS..

54% of respondents (n=53) selected a Uniform Distribution of Horizontally Vegetated GS as an OGS.

51% of respondents (n=50) selected a Mixed and Random Distribution of Vertically Vegetated GS as an OGS.

42% of respondents (n=42) selected a Densely Vegetated GS as an OGS.

50% of respondents (n=49) selected a GS located Close or directly adjacent to a heavy trafficked road as an OGS.

45% of respondents (n=31) selected a GS with a Limited amount or zero (0)Extensive and long views when located within the GS as an OGS.

Overall, only two eco-spatial structural characteristics changed between the Vantaa sample's FGS and OGS. Whereas Shape, Proximity, Edge, Maintenance and Management and Safety were the only characteristics to be consistent, the following changes were reported:

(Size)	Moderate levels of density in FGS and GS but high levels of density in OGS
(Lvl Green)	Moderate levels of views within FGS but limited views in OGS and GS

Table x.x
GS Characteristic Comparison Summary – Vantaa CA

Appendix 20 - Descriptive Analysis Results – Non-Structural Landscape Factors – Grouping 1

Paisley CA

Favourite Green Spaces Visited – FGS

≤ 113 individual FGS locations (n=113) provided by respondents

Maintenance and Management Characteristics

58%% of respondents (n=65) selected a Clean and well maintained or managed GS as a FGS.

45% of respondents (n=51) selected a GS with Abundant Facilities as a FGS.

39% of respondents (n=44) selected a GS with both Paved and Unpaved Paths as a FGS.

53% of respondents (n=60) selected a GS with Facilities that Promote High Sociability as a FGS.

Safety and Security Characteristics

73%% of respondents (n=79) selected a Somewhat Safe GS as a FGS.

Other Green Spaces Visited – OGS

≤ 69 individual OGS locations (n=69) provided by respondents

Maintenance and Management Characteristics

54% of respondents (n=37) selected a Moderately Clean and adequately maintained or managed GS as an OGS.

39% of respondents (n=27) selected a GS with Abundant Facilities as an OGS.

48% of respondents (n=33) selected a GS with primarily Paved Paths as an OGS.

60% of respondents (n=44) selected a GS with Facilities that Promote High Sociability as an OGS.

Safety and Security Characteristics

59%% of respondents (n=41) selected a Somewhat Safe GS as an OGS.

Vantaa CA

Favourite Green Spaces Visited – FGS

≤ 145 individual FGS locations (n=145) provided by respondents

Maintenance and Management Characteristics

59% of respondents (n=86) selected a Moderately Clean and maintained or managed GS as a FGS.

46% of respondents (n=66) selected a GS with Adeqate Facilities as a FGS.

56% of respondents (n=81) selected a GS with Unpaved Paths as a FGS.

50% of respondents (n=73) selected a GS with Facilities that Promote Mixed Sociability as a FGS.

Safety and Security Characteristics

63% of respondents (n=91) selected a Somewhat Safe GS as a FGS

Other Green Spaces Visited – OGS

≤ *102 individual OGS locations (n=102) provided by respondents*

Maintenance and Management Characteristics

59% of respondents (n=59) selected a Moderately Clean and adequately maintained or managed GS as an OGS.

47% of respondents (n=46) selected a GS with Adequate Facilities as an OGS.

60% of respondents (n=59) selected a GS with primarily Unpaved Paths as an OGS.

46% of respondents (n=45) selected a GS with Facilities that Promote Moderate Sociability as an OGS.

Safety and Security Characteristics

45% of respondents (n=45) selected a Somewhat Safe GS as an OGS.

Appendix 21 - Descriptive Analysis Results – HWB Interaction Factors

Paisley CA

FGS Affordance (physical, social, psychological)
113 individual FGS locations and affordances (n=113) provided by respondents.

54.0% (n=61) visited FGS for psychological affordances
23.9% (n=27) visited FGS for social affordances
22.1% (n=25) visited FGS for physical affordances.

Overall, most respondents visited FGS for psychological based HWB benefits.

OGS Affordance (physical, social, psychological)
49 individual OGS locations (n=49) provided by respondents.
69 individual OGS affordances (n=69) provided by respondents.

28.9% (n=33) visited OGS for psychological affordances
26.3% (n=30) visited OGS for social affordances
44.7% (n=51) visited OGS for physical affordances

Overall, most respondents visited OGS for physical based HWB benefits.

Vantaa CA

FGS Affordance (physical, social, psychological)
145 individual FGS locations and affordances (n=145) provided by respondents.

36.6% (n=53) visited FGS for psychological affordances
18.6% (n=27) visited FGS for social affordances
44.8% (n=65) visited FGS for physical affordances.

Overall, most respondents visited GS for physical based HWB benefits.

OGS Affordance (physical, social, psychological)
102 individual OGS locations. (n=102) provided by respondents
178 individual OGS affordances (n=178) provided by respondents.

32% (n=57) visited OGS for psychological affordances
20% (n=36) visited OGS for social affordances
48% (n=85) visited OGS for physical affordances

Overall, most respondents visited OGS for physical based HWB benefits.

Appendix 22 - Exploratory Factor Analysis (EFA) Results

Paisley, Scotland Data EFA

Input Data Type	Raw Data
Number of Records Read	84
Number of Records Used	60
N for Significance Tests	60
Prior Communality Estimates: ONE	

Eigenvalues of the Correlation Matrix: Total = 24 Average = 1				
	Eigenvalue	**Difference**	**Proportion**	**Cumulative**
1	7.47481766	3.87762223	0.3115	0.3115
2	3.59719543	1.07820422	0.1499	0.4613
3	2.51899121	0.78472593	0.1050	0.5663
4	1.73426527	0.58106440	0.0723	0.6386
5	1.15320087	0.11129547	0.0481	0.6866
6	1.04190540	0.15096248	0.0434	0.7300
7	0.89094293	0.03682295	0.0371	0.7671
8	0.85411998	0.13070833	0.0356	0.8027
9	0.72341165	0.06583305	0.0301	0.8329
10	0.65757860	0.15891800	0.0274	0.8603
11	0.49866059	0.05721148	0.0208	0.8810
12	0.44144911	0.05940645	0.0184	0.8994
13	0.38204266	0.03971575	0.0159	0.9154
14	0.34232691	0.03584653	0.0143	0.9296
15	0.30648039	0.04257595	0.0128	0.9424
16	0.26390444	0.02441514	0.0110	0.9534
17	0.23948929	0.04203911	0.0100	0.9634
18	0.19745018	0.02404900	0.0082	0.9716
19	0.17340118	0.04184294	0.0072	0.9788
20	0.13155824	0.00225061	0.0055	0.9843
21	0.12930763	0.01146142	0.0054	0.9897
22	0.11784620	0.04312564	0.0049	0.9946

23	0.07472056	0.01978695	0.0031	0.9977
24	0.05493361		0.0023	1.0000

6 factors will be retained by the MINEIGEN criterion.

Factor Pattern											
	Factor1		**Factor2**		**Factor3**		**Factor4**		**Factor5**		
GS_Shape	**Shape - Regulation Greeness Characteristic**	86	*	14		14		-4		16	
GS_Setting	**Level of Green - Vegetation Composition - Setting**	85	*	8		-5		-29		18	
GS_Horizontal	**Level of Green - Vegetation Structure - Horizontal**	78	*	21		-16		17		-10	

GS_Vertical	**Level of Green - Vegetation Structure - Vertical**	69	*	25		-27		36		12	
GS_V_Density	**Level of Green - Vegetation Structure - Density**	63	*	17		-43	*	4		-33	
GS_EdgeDensity	**Edge - Edge Density**	60	*	10		-47	*	19		-15	
GS_NN	**Proximity - Nearest GS Neighbour**	59	*	-5		57	*	3		-2	
GS_Isolation	**Proximity - Isolation and Connectivity**	58	*	-7		54	*	22		-8	
GS_Coherence	**Proximity - Level of**	51	*	-11		47	*	32		-39	

	Coherence										
GS_Size_Area	**Size - Area Characteristics**	51	*	39		7		32		31	
GS_SocialSpaces	**Maintenance and Management - Facilities - Sociability**	-66	*	33		20		26		-10	
GS_Paths	**Maintenance and Management - Facilities - Paths**	-72	*	23		-24		32		-24	
GS_Visibility	**Level of Green - Vegetation Structure - Visibility**	-74	*	4		45	*	4		0	
GS_Safety	**Safety and Security**	-74	*	10		8		24		-5	
GS_T	**Edge**	11		81	*	2		-36		-11	

otalEdge	**- Total Edge**										
GS_Complexity	**Shape - Complexity and Diversity**	9		77	*	-2		-38		1	
GS_Largest	**Size - Largest Characteristic**	-8		70	*	40	*	17		15	
GS_LongestEdge	**Edge - Longest Edge**	-11		66	*	27		20		11	
GS_Facilities	**Maintenance and Management - Facilities**	-53	*	55	*	-5		22		-23	
GS_Regulation	**Shape - Regulation**	-23		-73	*	9		21		13	
GS_Density	**Size - Density Characteristic**	52	*	-14		64	*	11		-7	
GS_RoadProximity	**Level of Green - Proximity to**	-17		16		-35		54	*	31	

	Heavy Traffic Road										
GS_LevelOfGreen	**Level of Green - Vegetation Composition**	37		-15		-24		47	*	15	
GS_Cleanliness	**Maintenance and Management - Cleanliness**	-34		8		9		-9		61	*
Printed values are multiplied by 100 and rounded to the nearest integer. Values greater than 0.4 are flagged by an '*'.											

Factor Pattern			

	Factor6		
GS_Shape	**Shape - Regulation Greeness Characteristic**	-16	
GS_Setting	**Level of Green - Vegetation Composition - Setting**	-4	
GS_Horizontal	**Level of Green - Vegetation Structure - Horizontal**	-4	
GS_Vertical	**Level of Green - Vegetation Structure - Vertical**	18	
GS_V_Density	**Level of Green - Vegetation Structure - Density**	-24	
GS_EdgeDensity	**Edge - Edge Density**	7	
GS_NN	**Proximity - Nearest GS Neighbour**	12	
GS_Isolation	**Proximity - Isolation and Connectivity**	7	
GS_Coherence	**Proximity - Level of Coherence**	9	
GS_Size_Area	**Size - Area Characteristics**	-11	
GS_SocialSpaces	**Maintenanec and Management - Facilities - Sociability**	5	
GS_Paths	**Maintenance and Management - Facilities - Paths**	8	
GS_Visibility	**Level of Green - Vegetation Structure - Visibility**	-1	
GS_Safety	**Safety and Security**	-18	
GS_TotalEdge	**Edge - Total Edge**	5	
GS_Complexity	**Shape - Complexity and Diversity**	25	
GS_Largest	**Size - Largest Characteristic**	-30	
GS_LongestEdge	**Edge - Longest Edge**	-43	*

GS_Facilities	**Maintenance and Management - Facilities**	19	
GS_Regulation	**Shape - Regulation**	-21	
GS_Density	**Size - Density Characteristic**	38	
GS_RoadProximity	**Level of Green - Proximity to Heavy Traffic Road**	44	*
GS_LevelOfGreen	**Level of Green - Vegetation Composition**	-20	
GS_Cleanliness	**Maintenance and Management - Cleanliness**	20	
Printed values are multiplied by 100 and rounded to the nearest integer. Values greater than 0.4 are flagged by an '*'.			

Variance Explained by Each Factor					
Factor1	**Factor2**	**Factor3**	**Factor4**	**Factor5**	**Factor6**
7.4748177	3.5971954	2.5189912	1.7342653	1.1532009	1.0419054

Final Communality Estimates: Total = 17.520376						
GS_Size_Area	**GS_Density**	**GS_Largest**	**GS_Shape**	**GS_Regulation**	**GS_Complexity**	**GS_NN**
0.62637373	0.85114929	0.79631867	0.82233356	0.70916269	0.81404817	0.70099944

GS_Isolation	**GS_Coherence**	**GS_TotalEdge**	**GS_LongestEdge**	**GS_EdgeDensity**	**GS_LevelOfGreen**
0.69092927	0.76547992	0.82153728	0.75438047	0.65647210	0.49665339

GS_Setting	**GS_Horizon**	**GS_Vertical**	**GS_V_Densi**	**GS_RoadPr**	**GS_Visibilit**

	tal		ty	oximity	y
0.84589477	0.71630349	0.79201364	0.76781447	0.75118848	0.75903142

GS_Cleanliness	GS_Facilities	GS_Paths	GS_SocialSpaces	GS_Safety
0.54902134	0.72334494	0.79586862	0.65514203	0.65891468

Orthogonal Transformation Matrix						
	1	2	3	4	5	6
1	0.62660	-0.60831	0.45160	0.09887	-0.01704	-0.15272
2	0.19716	0.24512	-0.07221	0.77056	0.54665	0.05690
3	-0.56868	-0.06150	0.73784	-0.02093	0.35546	0.04028
4	0.49187	0.58664	0.27307	-0.49349	0.27683	0.13853
5	0.01435	-0.38424	-0.20761	-0.16343	0.28283	0.83806
6	0.05441	0.27260	0.35884	0.35466	-0.64645	0.50027

Rotated Factor Pattern											
	Factor1		Factor2		Factor3		Factor4		Factor5		
GS_Vertical	Level of Green - Vegetation Structure - Vertical	82	*	-13		24		13		5	
GS_Edge Density	Edge - Edge Density	76	*	-13		2		11		-16	
GS_Horizontal	Level of Green - Vegetation Structure - Horizontal	70	*	-28		27		16		9	
GS_V_Density	Level of Green - Vegetation Structure - Density	67	*	-23		-5		15		0	
GS_LevelOfGreen	Level of Green - Vegetation	56	*	-9		3		-40		13	

	Composition										
GS_Size_Area	**Size - Area Characteristics**	52	*	-18		24		10		47	*
GS_Visibility	**Level of Green - Vegetation Structure - Visibility**	-70	*	46	*	1		-8		21	
GS_Paths	**Maintenance and Management - Facilities - Paths**	-11		81	*	-35		2		2	
GS_Facilities	**Maintenance and Management - Facilities**	-8		73	*	-14		37		16	
GS_SocialSpaces	**Maintenanec and Management - Facilities - Sociability**	-33		67	*	-6		9		27	
GS_Safety	**Safety and Security**	-38		58	*	-27		-17		26	
GS_Shape	**Shape - Regulation Greeness Characteristic**	46	*	-62	*	38		13		24	
GS_Setting	**Level of Green - Vegetation Composition - Setting**	43	*	-74	*	21		24		0	
GS_Density	**Size - Density Characteristic**	0		-19		89	*	2		-9	
GS_Coherence	**Proximity - Level of Coherence**	19		0		79	*	-11		2	
GS_Isola	**Proximity**	15		-22		77	*	-8		14	

tion	**- Isolation and Connectivity**										
GS_NN	**Proximity - Nearest GS Neighbour**	6		-35		75	*	4		9	
GS_Complexity	**Shape - Complexity and Diversity**	5		-2		-5		88	*	15	
GS_TotalEdge	**Edge - Total Edge**	4		-3		-5		85	*	29	
GS_Regulation	**Shape - Regulation**	-25		-3		-3		-79	*	-13	
GS_LongestEdge	**Edge - Longest Edge**	-2		17		-2		22		82	*
GS_Largest	**Size - Largest Characteristic**	-7		15		12		30		81	*
GS_Cleanliness	**Maintenance and Management - Cleanliness**	-27		-2		-17		4		10	
GS_RoadProximity	**Level of Green - Proximity to Heavy Traffic Road**	42	*	48	*	-10		-5		-8	
Printed values are multiplied by 100 and rounded to the nearest integer. Values greater than 0.4 are flagged											

by an '*'.											

Rotated Factor Pattern			
	Factor6		
GS_Vertical	Level of Green - Vegetation Structure - Vertical	14	
GS_EdgeDensity	Edge - Edge Density	-17	
GS_Horizontal	Level of Green - Vegetation Structure - Horizontal	-19	
GS_V_Density	Level of Green - Vegetation Structure - Density	-49	*
GS_LevelOfGreen	Level of Green - Vegetation Composition	2	
GS_Size_Area	Size - Area Characteristics	20	
GS_Visibility	Level of Green - Vegetation Structure - Visibility	13	
GS_Paths	Maintenance and Management - Facilities - Paths	0	
GS_Facilities	Maintenance and Management - Facilities	4	
GS_SocialSpaces	Maintenanec and Management - Facilities - Sociability	10	
GS_Safety	Safety and Security	2	
GS_Shape	Shape - Regulation Greeness Characteristic	-7	
GS_Setting	Level of Green - Vegetation Composition - Setting	-4	
GS_Density	Size - Density Characteristic	8	
GS_Coherence	Proximity - Level of	-31	

	Coherence		
GS_Isolation	**Proximity - Isolation and Connectivity**	-7	
GS_NN	**Proximity - Nearest GS Neighbour**	-2	
GS_Complexity	**Shape - Complexity and Diversity**	11	
GS_TotalEdge	**Edge - Total Edge**	-9	
GS_Regulation	**Shape - Regulation**	3	
GS_LongestEdge	**Edge - Longest Edge**	-3	
GS_Largest	**Size - Largest Characteristic**	7	
GS_Cleanliness	**Maintenance and Management - Cleanliness**	66	*
GS_RoadProximity	**Level of Green - Proximity to Heavy Traffic Road**	57	*
Printed values are multiplied by 100 and rounded to the nearest integer. Values greater than 0.4 are flagged by an '*'.			

Variance Explained by Each Factor					
Factor1	**Factor2**	**Factor3**	**Factor4**	**Factor5**	**Factor6**
4.3121970	3.8361454	3.2277362	2.7942661	2.0559622	1.2940689

Final Communality Estimates: Total = 17.520376						
GS_Size_Area	**GS_Density**	**GS_Largest**	**GS_Shape**	**GS_Regulation**	**GS_Complexity**	**GS_NN**
0.62637373	0.85114929	0.79631867	0.82233356	0.70916269	0.81404817	0.70099944

GS_Isolation	**GS_Coheren**	**GS_TotalEd**	**GS_Longest**	**GS_EdgeDe**	**GS_LevelOf**

	ce	ge	Edge	nsity	Green
0.69092927	0.76547992	0.82153728	0.75438047	0.65647210	0.49665339

GS_Setting	GS_Horizontal	GS_Vertical	GS_V_Density	GS_RoadProximity	GS_Visibility
0.84589477	0.71630349	0.79201364	0.76781447	0.75118848	0.75903142

GS_Cleanliness	GS_Facilities	GS_Paths	GS_SocialSpaces	GS_Safety
0.54902134	0.72334494	0.79586862	0.65514203	0.65891468

Input Data Type	Raw Data
Number of Records Read	55
Number of Records Used	55
N for Significance Tests	55
Prior Communality Estimates: ONE	

Eigenvalues of the Correlation Matrix: Total = 5 Average = 1				
	Eigenvalue	**Difference**	**Proportion**	**Cumulative**
1	2.37015596	1.11088156	0.4740	0.4740
2	1.25927440	0.40465609	0.2519	0.7259
3	0.85461831	0.51703527	0.1709	0.8968
4	0.33758304	0.15921477	0.0675	0.9643
5	0.17836828		0.0357	1.0000

2 factors will be retained by the MINEIGEN criterion.

Factor Pattern					
	Factor1		**Factor2**		
AVG_Education_Level	**Education Level (AVG per PostCode)**	93	*	-3	
AVG_Household_Income	**Household Income Level (AVG per PostCode)**	92	*	6	

Depravity_Quintile_Ranking	**Depravity Quintile Ranking Scores**	81	*	-1	
Gender	**Respondent's Gender**	8		80	*
Age	**Respondent's Age**	10		-78	*
Printed values are multiplied by 100 and rounded to the nearest integer. Values greater than 0.4 are flagged by an '*'.					

Variance Explained by Each Factor	
Factor1	**Factor2**
2.3701560	1.2592744

Final Communality Estimates: Total = 3.629430				
Age	**Gender**	**Depravity_Quintile_Ranking**	**AVG_Household_Income**	**AVG_Education_Level**
0.62381391	0.64604256	0.65347265	0.84202378	0.86407748

Orthogonal Transformation Matrix		
	1	**2**
1	0.99998	-0.00686
2	0.00686	0.99998

Rotated Factor Pattern					
	Factor1		**Factor2**		

AVG_Education_Level	**Education Level (AVG per PostCode)**	93	*	-4	
AVG_Household_Income	**Household Income Level (AVG per PostCode)**	92	*	5	
Depravity_Quintile_Ranking	**Depravity Quintile Ranking Scores**	81	*	-2	
Gender	**Respondent's Gender**	9		80	*
Age	**Respondent's Age**	9		-78	*
Printed values are multiplied by 100 and rounded to the nearest integer. Values greater than 0.4 are flagged by an '*'.					

Variance Explained by Each Factor	
Factor1	**Factor2**
2.3701037	1.2593267

Final Communality Estimates: Total = 3.629430				
Age	**Gender**	**Depravity_Quintile_Ranking**	**AVG_Household_Income**	**AVG_Education_Level**
0.62381391	0.64604256	0.65347265	0.84202378	0.86407748

Appendix 23 - Factor Analysis (FA) Results

This factor analysis again utilised the M-H test of linear regression. The cut-off limit for an item to be regarded as a significant contributor to a factor was a loading of at least 0.50. Logistic (block-wise, backward) regression analysis was ran to obtain an impression of the impact of GS eco-spatial characteristics on self-reported life satisfaction levels.

Blocking Strategy

The following blocking strategy of the eco-spatial GS characteristics, X1, and socio-demographic characteristics (X2) was coordinated specific to landscape fragmentation and the similar spatial characteristics within homogenous groups.

X1 – Eco-Spatial Characteristics

Block 1 - (Fragmentation Characteristics)
- a. Edge - Total
- b. Edge - Density
- c. Size - Density
- d. Shape - Regulation
- e. Shape - Complexity and Diversity
- f. Proximity - Nearest GS Neighbour
- g. Proximity - Isolation and Connectivity
- h. Proximity - Level of Coherence

Block 2 - (Maintenance & Safety)
- a. Maintenance & Management
  - Cleanliness
  - Facilities
  - Facilities - Paths
  - Facilities - Sociability
- b. Safety and Security

Block 3 - (Vegetative Characteristics)
- a. Level of Greenness
  - Vegetation Composition
  - Vegetation Density
  - Horizontal Structure
  - Vertical Structure
  - Visibility

Block 4 - (Composition Characteristics)
- a. Level of Greenness - Vegetation Composition - Setting
- b. Level of Greenness - Proximity to Heavy Traffic Road
- c. Shape - Regulation - Greenness Characteristic

Block 5 - (Edge Structure)
- a. Edge
  - Total Edge
  - Longest Edge
  - Edge Density

Block 6 - (Size Structure)
a. Size
Area
Density
Largest

Block 7 - (Shape Structure)
a. Shape
Regulation
Complexity and Diversity

Block 8 - (Proximity Structure)
a. Proximity
Nearest GS Neighbour
Isolation and Connectivity
Level of Coherence

Paisley, Scotland Data FA

Number of Observations Read	182
Number of Observations Used	127

Response Profile		
Ordered Value	**Life_Satisfaction_full**	**Total Frequency**
1	Neither Satisfied or Unsatisfied	4
2	Satisfied	62
3	Unsatisfied	15
4	Very Satisfied	38
5	Very Unsatisfied	8

Probabilities modeled are cumulated over the lower Ordered Values.

Note:	55 observations were deleted due to missing values for the response or explanatory variables.

Stepwise Selection Procedure

Class Level Information						
Class	**Value**	**Design Variables**				
GS_Cleanli	**Close**	1				

ness						
	Moderate	0				
GS_Coherence	**Gardens and Grounds**	1				
	Park	0				
GS_Complexity	**Complex**	1	0	0		
	Linear	0	1	0		
	Moderate	0	0	1		
	Simple	0	0	0		
GS_Density	**High Density**	1	0			
	Low Density	0	1			
	Moderate Density	0	0			
GS_EdgeDensity	**Dense**	1	0			
	Moderate	0	1			
	Transparent	0	0			
GS_Facilities	**Abundant**	1	0			
	Adequate	0	1			
	Inadequate	0	0			
GS_Horizontal	**Clustered**	1	0			
	Diverse and Random	0	1			
	Uniform	0	0			

GS_Isolation	**Grouped**	1	0			
	Isolated	0	1			
	Moderate	0	0			
GS_Largest	**Largest**	1	0			
	Moderate	0	1			
	Small	0	0			
GS_LevelOfGreen	**3**	1	0	0		
	4	0	1	0		
	East-West	0	0	1		
	North-South	0	0	0		
GS_LongestEdge	**Moderate**	1	0			
	Natural	0	1			
	Urban	0	0			
GS_NN	**Connected**	1	0			
	Nearby	0	1			
	Separated	0	0			
GS_Paths	**Mixed**	1	0			
	Paved	0	1			
	Unpaved	0	0			
GS_Regulation	**Irregular**	1	0	0		
	Linear	0	1	0		
	Moderate	0	0	1		
	Regular	0	0	0		
GS_RoadProximity	**Few**	1	0			

	Moderate	0	1			
	Numerous	0	0			
GS_Safety	**Coniferous**	1	0			
	Deciduous	0	1			
	Mixed	0	0			
GS_Setting	**Complex**	1	0	0		
	Linear	0	1	0		
	Moderate	0	0	1		
	Simple	0	0	0		
GS_Shape	**Bike**	1	0			
	Car	0	1			
	Walk	0	0			
GS_Size_Area	**Extensive**	1	0			
	Limited	0	1			
	Moderate	0	0			
GS_SocialSpaces	**Conditional Access**	1	0			
	Full Access	0	1			
	Remote Access	0	0			
GS_TotalEdge	**Extensive**	1	0			
	Limited	0	1			
	Moderate	0	0			
GS_Typology	**Green Corridor**	1	0	0	0	0
	Other Including Cemeterie	0	1	0	0	0

	s and Churchyards, Civic Spaces, Water & Wetlands					
	Other Natural or Semi-Natural GS	0	0	1	0	0
	Outdoor Sports Facilities & Children's Play Area	0	0	0	1	0
	Parks and Gardens and Amenity Spaces	0	0	0	0	1
	Woodlands and Grasslands and Agricultural	0	0	0	0	0
GS_V_Density	**Autonomous**	1	0			
	Integrated	0	1			
	Linear Corridor	0	0			
GS_Vertical	**Clustered**	1	0			
	Diverse and Random	0	1			
	Uniform	0	0			
GS_Visibility	**Least**	1	0			
	Longest	0	1			
	Moderate	0	0			

Step 0. Intercepts entered:

Model Convergence Status
Convergence criterion (GCONV=1E-8) satisfied.

-2 Log L	=	316.599

Residual Chi-Square Test		
Chi-Square	**DF**	**Pr > ChiSq**
56.8847	54	0.3682

Step 1. Effect GS_Typology entered:

Model Convergence Status
Convergence criterion (GCONV=1E-8) satisfied.

Score Test for the Proportional Odds Assumption		
Chi-Square	**DF**	**Pr > ChiSq**
62.8390	15	<.0001

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	324.599	323.561
SC	335.976	349.159
-2 Log L	316.599	305.561

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	11.0380	5	0.0506
Score	10.0533	5	0.0737
Wald	10.6978	5	0.0577

Residual Chi-Square Test		
Chi-Square	**DF**	**Pr > ChiSq**
50.3463	49	0.4199

Note:	No effects for the model in Step 1 are removed.

Step 2. Effect GS_Paths entered:

Model Convergence Status
Convergence criterion (GCONV=1E-8) satisfied.

Score Test for the Proportional Odds Assumption		
Chi-Square	**DF**	**Pr > ChiSq**
66.4219	21	<.0001

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	324.599	322.694
SC	335.976	353.980
-2 Log L	316.599	300.694

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	15.9050	7	0.0260
Score	15.1762	7	0.0338
Wald	14.7073	7	0.0399

Residual Chi-Square Test		
Chi-Square	**DF**	**Pr > ChiSq**
46.3796	47	0.4982

Step 3. Effect GS_Paths is removed:

Model Convergence Status
Convergence criterion (GCONV=1E-8) satisfied.

Score Test for the Proportional Odds Assumption		
Chi-Square	**DF**	**Pr > ChiSq**
62.8390	15	<.0001

Model Fit Statistics		
Criterion	**Intercept Only**	**Intercept and Covariates**
AIC	324.599	323.561
SC	335.976	349.159
-2 Log L	316.599	305.561

Testing Global Null Hypothesis: BETA=0			
Test	**Chi-Square**	**DF**	**Pr > ChiSq**
Likelihood Ratio	11.0380	5	0.0506
Score	10.0533	5	0.0737
Wald	10.6978	5	0.0577

Residual Chi-Square Test		
Chi-Square	**DF**	**Pr > ChiSq**
50.3463	49	0.4199

Note:	No effects for the model in Step 3 are removed.

Note:	Model building terminates because the last effect entered is removed by the Wald statistic criterion.

Summary of Stepwise Selection								

Step	Effect Entered	DF Removed	Number In	Score Chi-Square	Wald Chi-Square	Pr > ChiSq	Variable Label	
1	GS_Typology		5	1	10.0533		0.0737	Green Space Typological Definition
2	GS_Paths		2	2	5.1391		0.0766	Maintenance and Management - Facilities - Paths
3		GS_Paths	2	1		4.5641	0.1021	Maintenance and Management - Facilities - Paths

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
GS_Typology	5	10.6978	0.0577

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > ChiSq**
Intercept	**Neither Satisfied or Unsatisfied**	1	-2.8300	0.8437	11.2508	0.0008
Intercept	**Satisfied**	1	0.8184	0.7202	1.2910	0.2559
Intercept	**Unsatisfied**	1	1.3386	0.7262	3.3973	0.0653
Intercept	**Very Satisfied**	1	3.6035	0.8045	20.0614	<.0001
GS_Typology	**Green Corridor**	1	1.0060	1.7217	0.3414	0.5590
GS_Typolo	**Other**	1	0.1365	0.9151	0.0222	0.8815

gy	**Including Cemeteries and Churchyards, Civic Spaces, Water & Wetlands**					
GS_Typology	**Other Natural or Semi-Natural GS**	1	-0.6181	0.9554	0.4186	0.5176
GS_Typology	**Outdoor Sports Facilities & Children's Play Area**	1	-1.9797	0.8737	5.1341	0.0235
GS_Typology	**Parks and Gardens and Amenity Spaces**	1	-0.8119	0.7478	1.1787	0.2776

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
GS_Typology Green Corridor vs Woodlands and Grasslands and Agricultural	2.735	0.094	79.874
GS_Typology Other Including Cemeteries and Churchyards, Civic Spaces, Water & Wetlands vs Woodlands and Grasslands and Agricultural	1.146	0.191	6.890
GS_Typology Other Natural or Semi-Natural GS vs Woodlands and Grasslands and Agricultural	0.539	0.083	3.506
GS_Typology Outdoor Sports	0.138	0.025	0.765

Facilities & Children's Play Area vs Woodlands and Grasslands and Agricultural			
GS_Typology Parks and Gardens and Amenity Spaces vs Woodlands and Grasslands and Agricultural	0.444	0.103	1.923

Association of Predicted Probabilities and Observed Responses						
Percent Concordant	39.7	**Somers' D**	0.221			
Percent Discordant	17.7	**Gamma**	0.384			
Percent Tied	42.6	**Tau-a**	0.145			
Pairs	5268	**c**	0.610			
Table of GS_Typology by Life_Satisfaction_full						
GS_Typology(Green Space Typological Definition)	**Life_Satisfaction_full (LIFE SATISFACTION)**					
Frequency Percent Row Pct Col Pct	**Very Satisfied**	**Satisfied**	**Neither Satisfied or Unsatisfied**	**Unsatisfied**	**Very Unsatisfied**	**Total**
Parks and Gardens and Amenity Spaces	30 17.75 30.61 60.00	49 28.99 50.00 58.33	3 1.78 3.06 42.86	12 7.10 12.24 63.16	4 2.37 4.08 44.44	98 57.99
Woodlands and	3 1.78 18.75 6.00	7 4.14 43.75 8.33	1 0.59 6.25 14.29	4 2.37 25.00 21.05	1 0.59 6.25 11.11	16 9.47

Grasslands and Agricultural						
Other Natural or Semi-Natural GS	5 2.96 38.46 10.00	6 3.55 46.15 7.14	1 0.59 7.69 14.29	1 0.59 7.69 5.26	0 0.00 0.00 0.00	13 7.69
Outdoor Sports Facilities & Children's Play Area	7 4.14 43.75 14.00	6 3.55 37.50 7.14	0 0.00 0.00 0.00	0 0.00 0.00 0.00	3 1.78 18.75 33.33	16 9.47
Green Corridor	3 1.78 27.27 6.00	6 3.55 54.55 7.14	1 0.59 9.09 14.29	0 0.00 0.00 0.00	1 0.59 9.09 11.11	11 6.51
Other Including Cemeteries and Churchyards, Civic Spaces, Water & Wetlands	2 1.18 13.33 4.00	10 5.92 66.67 11.90	1 0.59 6.67 14.29	2 1.18 13.33 10.53	0 0.00 0.00 0.00	15 8.88
Total	50 29.59	84 49.70	7 4.14	19 11.24	9 5.33	169 100.00
Frequency Missing = 13						

Appendix 24 - Data Modification

Introduction

This Appendix describes the approach for modifying the variables post EFA in order to structure the data prior to another FA and simplify and strengthen data analysis.

Life Satisfaction (Y)

The dependent variable, Life Satisfaction (Y) required a simplified recoding of its levels. The experiment design and SQ included five LS rankings; this was reduced to three in the analysis process

Very Satisfied and Satisfied
Neither Satisfied nor Unsatisfied
Very Unsatisfied and Unsatisfied

Green Space Typology

The experimental design included fifteen green structure typologies. During the data analysis and interaction phase, these were combined into six (6) typologies:

Parks and Gardens and Amenity Spaces
Woodlands and Grasslands and Agricultural
Other Natural or Semi-Natural GS
Outdoor Sports Facilities & Children's Play Areas
Green Corridor
Other Including Cemeteries and Churchyards, Civic Spaces, Water & Wetlands

These new grouped typologies are considered to be similar typologies in as much as possible in order to keep the distinctness of each green structure typology intact. These typological groupings also reflect similar typologies utilised in other research (e.g. Bell et al., 2007; Swanwick et al., 2003).

Appendix 25 - Descriptive Analysis – Crosstabulation Results

Paisley, Scotland LS Crosstabulation Analysis Results

Of 55 survey respondents (n=55), 48 gave a self-reported Life Satisfaction score (87.3%).

LIFE SATISFACTION * Respondent's Age Crosstabulation									
			Respondent's Age						Total
			18-24	25-34	35-44	45-54	55-64	65-75	
LIFE SATISFACTION	Satisfied & Very Satisfied	Count	1	4	4	16	8	4	37
		% within LIFE SATISFACTION	2.7%	10.8%	10.8%	43.2%	21.6%	10.8%	100.0%
		% within Respondent's Age	100.0%	57.1%	80.0%	80.0%	80.0%	80.0%	77.1%
		% of Total	2.1%	8.3%	8.3%	33.3%	16.7%	8.3%	77.1%
	Neither Satisfied or Unsatisfied	Count	0	2	0	0	1	1	4
		% within LIFE SATISFACTION	0.0%	50.0%	0.0%	0.0%	25.0%	25.0%	100.0%
		% within Respondent's Age	0.0%	28.6%	0.0%	0.0%	10.0%	20.0%	8.3%
		% of Total	0.0%	4.2%	0.0%	0.0%	2.1%	2.1%	8.3%
	Unsatisfied & Very Unsatisfied	Count	0	1	1	4	1	0	7
		% within LIFE SATISFACTION	0.0%	14.3%	14.3%	57.1%	14.3%	0.0%	100.0%
		% within Respondent's Age	0.0%	14.3%	20.0%	20.0%	10.0%	0.0%	14.6%
		% of Total	0.0%	2.1%	2.1%	8.3%	2.1%	0.0%	14.6%
Total		Count	1	7	5	20	10	5	48
		% within LIFE SATISFACTION	2.1%	14.6%	10.4%	41.7%	20.8%	10.4%	100.0%
		% within Respondent's Age	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	2.1%	14.6%	10.4%	41.7%	20.8%	10.4%	100.0%

LIFE SATISFACTION * Respondent's Gender Crosstabulation					
			Respondent's Gender		Total
			Male	Female	
LS	Satisfied & Very Satisfied	Count	22	15	37
		% within LIFE SATISFACTION	59.5%	40.5%	100.0 %
		% within Respondent's Gender	78.6%	75.0%	77.1%
		% of Total	45.8%	31.3%	77.1%
	Neither Satisfied or Unsatisfied	Count	2	2	4
		% within LIFE SATISFACTION	50.0%	50.0%	100.0 %
		% within Respondent's Gender	7.1%	10.0%	8.3%
		% of Total	4.2%	4.2%	8.3%
	Unsatisfied & Very Unsatisfied	Count	4	3	7
		% within LIFE SATISFACTION	57.1%	42.9%	100.0 %
		% within Respondent's Gender	14.3%	15.0%	14.6%
		% of Total	8.3%	6.3%	14.6%
Total		Count	28	20	48
		% within LIFE SATISFACTION	58.3%	41.7%	100.0 %
		% within Respondent's Gender	100.0%	100.0%	100.0 %
		% of Total	58.3%	41.7%	100.0 %

LIFE SATISFACTION * Depravity Quintile Ranking Scores Crosstabulation

			Depravity Quintile Ranking Scores									
			1%-10%	11%-20%	21%-30%	31%-40%	41%-50%	51%-60%	61%-70%	81%-90%	91%-100%	Total
LIFE SATISFACTION	Satisfied & Very Satisfied	Count	3	2	6	4	1	1	2	5	13	37
		% within LIFE SATISFACTION	8.1%	5.4%	16.2%	10.8%	2.7%	2.7%	5.4%	13.5%	35.1%	100.0%
		% within Depravity Quintile Ranking Scores	60.0%	66.7%	100.0%	100.0%	50.0%	33.3%	66.7%	71.4%	86.7%	77.1%
		% of Total	6.3%	4.2%	12.5%	8.3%	2.1%	2.1%	4.2%	10.4%	27.1%	77.1%
	Neither Satisfied or Unsatisfied	Count	1	0	0	0	1	1	0	0	1	4
		% within LIFE SATISFACTION	25.0%	0.0%	0.0%	0.0%	25.0%	25.0%	0.0%	0.0%	25.0%	100.0%
		% within Depravity Quintile Ranking Scores	20.0%	0.0%	0.0%	0.0%	50.0%	33.3%	0.0%	0.0%	6.7%	8.3%
		% of Total	2.1%	0.0%	0.0%	0.0%	2.1%	2.1%	0.0%	0.0%	2.1%	8.3%
	Unsatisfied & Very Unsatisfied	Count	1	1	0	0	0	1	1	2	1	7
		% within LIFE SATISFACTION	14.3%	14.3%	0.0%	0.0%	0.0%	14.3%	14.3%	28.6%	14.3%	100.0%
		% within Depravity Quintile Ranking Scores	20.0%	33.3%	0.0%	0.0%	0.0%	33.3%	33.3%	28.6%	6.7%	14.6%
		% of Total	2.1%	2.1%	0.0%	0.0%	0.0%	2.1%	2.1%	4.2%	2.1%	14.6%
Total		Count	5	3	6	4	2	3	3	7	15	48
		% within LIFE SATISFACTION	10.4%	6.3%	12.5%	8.3%	4.2%	6.3%	6.3%	14.6%	31.3%	100.0%
		% within Depravity Quintile Ranking Scores	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	10.4%	6.3%	12.5%	8.3%	4.2%	6.3%	6.3%	14.6%	31.3%	100.0%

LIFE SATISFACTION * Household Income Level (AVG per PostCode) Crosstabulation

			Household Income Level (AVG per PostCode)							
			0-5000	5000-10000	10000-15000	15000-20000	20000-30000	30000-40000	40000+	Total
LIFE SATISFACTION	Satisfied & Very Satisfied	Count	6	2	2	3	13	7	4	37
		% within LIFE SATISFACTION	16.2%	5.4%	5.4%	8.1%	35.1%	18.9%	10.8%	100.0%
		% within Household Income Level (AVG per PostCode)	60.0%	66.7%	100.0%	60.0%	92.9%	77.8%	80.0%	77.1%
		% of Total	12.5%	4.2%	4.2%	6.3%	27.1%	14.6%	8.3%	77.1%
	Neither Satisfied or Unsatisfied	Count	3	0	0	0	1	0	0	4
		% within LIFE SATISFACTION	75.0%	0.0%	0.0%	0.0%	25.0%	0.0%	0.0%	100.0%
		% within Household Income Level (AVG per PostCode)	30.0%	0.0%	0.0%	0.0%	7.1%	0.0%	0.0%	8.3%
		% of Total	6.3%	0.0%	0.0%	0.0%	2.1%	0.0%	0.0%	8.3%
	Unsatisfied & Very Unsatisfied	Count	1	1	0	2	0	2	1	7
		% within LIFE SATISFACTION	14.3%	14.3%	0.0%	28.6%	0.0%	28.6%	14.3%	100.0%
		% within Household Income Level (AVG per PostCode)	10.0%	33.3%	0.0%	40.0%	0.0%	22.2%	20.0%	14.6%
		% of Total	2.1%	2.1%	0.0%	4.2%	0.0%	4.2%	2.1%	14.6%
Total		Count	10	3	2	5	14	9	5	48
		% within LIFE SATISFACTION	20.8%	6.3%	4.2%	10.4%	29.2%	18.8%	10.4%	100.0%
		% within Household Income Level (AVG per PostCode)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	20.8%	6.3%	4.2%	10.4%	29.2%	18.8%	10.4%	100.0%

LIFE SATISFACTION * Education Level (AVG per PostCode) Crosstabulation

			Education Level (AVG per PostCode)					
			No Qualifications	GSCE and SVQ Level 1 or 2	A Levels, a few GSCEs, SVQ Level 3	Graduates, SVQ Level 4	Postgraduate Qualifications	Total
LIFE SATISFACTION	Satisfied & Very Satisfied	Count	4	5	5	8	15	37
		% within LIFE SATISFACTION	10.8%	13.5%	13.5%	21.6%	40.5%	100.0%
		% within Education Level (AVG per PostCode)	66.7%	55.6%	83.3%	88.9%	83.3%	77.1%
		% of Total	8.3%	10.4%	10.4%	16.7%	31.3%	77.1%
	Neither Satisfied or Unsatisfied	Count	1	2	0	0	1	4
		% within LIFE SATISFACTION	25.0%	50.0%	0.0%	0.0%	25.0%	100.0%
		% within Education Level (AVG per PostCode)	16.7%	22.2%	0.0%	0.0%	5.6%	8.3%
		% of Total	2.1%	4.2%	0.0%	0.0%	2.1%	8.3%
	Unsatisfied & Very Unsatisfied	Count	1	2	1	1	2	7
		% within LIFE SATISFACTION	14.3%	28.6%	14.3%	14.3%	28.6%	100.0%
		% within Education Level (AVG per PostCode)	16.7%	22.2%	16.7%	11.1%	11.1%	14.6%
		% of Total	2.1%	4.2%	2.1%	2.1%	4.2%	14.6%
Total		Count	6	9	6	9	18	48
		% within LIFE SATISFACTION	12.5%	18.8%	12.5%	18.8%	37.5%	100.0%
		% within Education Level (AVG per PostCode)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	12.5%	18.8%	12.5%	18.8%	37.5%	100.0%

Vantaa, Finland LS Crosstabulation Analysis Results

Of 62 survey respondents (n=62), 52 gave a self-reported Life Satisfaction score (83.9%).

LIFE SATISFACTION * Gender Crosstabulation					
			Gender		Total
			Female	Male	
LIFE SATISFACTION	Satisfied & Very Satisfied	Count	21	19	40
		% within LIFE SATISFACTION	52.5%	47.5%	100.0%
		% within Gender	87.5%	67.9%	76.9%
		% of Total	40.4%	36.5%	76.9%
	Neither Satisfied or Unsatisfied	Count	2	7	9
		% within LIFE SATISFACTION	22.2%	77.8%	100.0%
		% within Gender	8.3%	25.0%	17.3%
		% of Total	3.8%	13.5%	17.3%
	Unsatisfied & Very Unsatisfied	Count	1	2	3
		% within LIFE SATISFACTION	33.3%	66.7%	100.0%
		% within Gender	4.2%	7.1%	5.8%
		% of Total	1.9%	3.8%	5.8%
Total		Count	24	28	52
		% within LIFE SATISFACTION	46.2%	53.8%	100.0%
		% within Gender	100.0%	100.0%	100.0%
		% of Total	46.2%	53.8%	100.0%

LIFE SATISFACTION * Respondent's Age Crosstabulation									
			Respondent's Age						Total
			18-24	25-34	35-44	45-54	55-64	65-75	
LIFE SATISFACTION	Satisfied & Very Satisfied	Count	6	11	6	11	5	1	40
		% within LIFE SATISFACTION	15.0%	27.5%	15.0%	27.5%	12.5%	2.5%	100.0%
		% within Respondent's Age	75.0%	91.7%	42.9%	100.0%	83.3%	100.0%	76.9%
		% of Total	11.5%	21.2%	11.5%	21.2%	9.6%	1.9%	76.9%
	Neither Satisfied or Unsatisfied	Count	2	1	6	0	0	0	9
		% within LIFE SATISFACTION	22.2%	11.1%	66.7%	0.0%	0.0%	0.0%	100.0%
		% within Respondent's Age	25.0%	8.3%	42.9%	0.0%	0.0%	0.0%	17.3%
		% of Total	3.8%	1.9%	11.5%	0.0%	0.0%	0.0%	17.3%
	Unsatisfied & Very Unsatisfied	Count	0	0	2	0	1	0	3
		% within LIFE SATISFACTION	0.0%	0.0%	66.7%	0.0%	33.3%	0.0%	100.0%
		% within Respondent's Age	0.0%	0.0%	14.3%	0.0%	16.7%	0.0%	5.8%
		% of Total	0.0%	0.0%	3.8%	0.0%	1.9%	0.0%	5.8%
Total		Count	8	12	14	11	6	1	52
		% within LIFE SATISFACTION	15.4%	23.1%	26.9%	21.2%	11.5%	1.9%	100.0%
		% within Respondent's Age	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	15.4%	23.1%	26.9%	21.2%	11.5%	1.9%	100.0%

LIFE SATISFACTION * At Risk of Poverty Threshold Ranking Crosstabulation				
			At Risk of Poverty Threshold Ranking	Total
			Income > 60% of Median Income (NO RISK)	
LIFE SATISFACTION	Satisfied & Very Satisfied	Count	40	40
		% within LIFE SATISFACTION	100.0%	100.0%
		% within At Risk of Poverty Threshold Ranking	76.9%	76.9%
		% of Total	76.9%	76.9%
	Neither Satisfied or Unsatisfied	Count	9	9
		% within LIFE SATISFACTION	100.0%	100.0%
		% within At Risk of Poverty Threshold Ranking	17.3%	17.3%
		% of Total	17.3%	17.3%
	Unsatisfied & Very Unsatisfied	Count	3	3
		% within LIFE SATISFACTION	100.0%	100.0%
		% within At Risk of Poverty Threshold Ranking	5.8%	5.8%
		% of Total	5.8%	5.8%
Total		Count	52	52
		% within LIFE SATISFACTION	100.0%	100.0%
		% within At Risk of Poverty Threshold Ranking	100.0%	100.0%
		% of Total	100.0%	100.0%

LIFE SATISFACTION * Education Level (AVG per PostCode) Crosstabulation					
			Education Level (AVG per PostCode)		Total
			Matriculation Exam	Vocational Diploma	
LIFE SATISFACTION	Satisfied & Very Satisfied	Count	6	34	40
		% within LIFE SATISFACTION	15.0%	85.0%	100.0%
		% within Education Level (AVG per PostCode)	66.7%	79.1%	76.9%
		% of Total	11.5%	65.4%	76.9%
	Neither Satisfied or Unsatisfied	Count	3	6	9
		% within LIFE SATISFACTION	33.3%	66.7%	100.0%
		% within Education Level (AVG per PostCode)	33.3%	14.0%	17.3%
		% of Total	5.8%	11.5%	17.3%
	Unsatisfied & Very Unsatisfied	Count	0	3	3
		% within LIFE SATISFACTION	0.0%	100.0%	100.0%
		% within Education Level (AVG per PostCode)	0.0%	7.0%	5.8%
		% of Total	0.0%	5.8%	5.8%
Total		Count	9	43	52
		% within LIFE SATISFACTION	17.3%	82.7%	100.0%
		% within Education Level (AVG per PostCode)	100.0%	100.0%	100.0%
		% of Total	17.3%	82.7%	100.0%

LIFE SATISFACTION * Household Income Level (AVG per PostCode) Crosstabulation

	Household Income Level (AVG per PostCode)							
	20000 - 30000	30000 - 35000	35000 - 40000	40000 - 45000	45000 - 50000	50000 - 60000	60000+	Total
Count	5	15	11	2	5	1	1	40
% within LIFE SATISFACTION	12.5%	37.5%	27.5%	5.0%	12.5%	2.5%	2.5%	100.0%
% within Household Income Level (AVG per PostCode)	83.3%	78.9%	78.6%	100.0%	71.4%	50.0%	50.0%	76.9%
% of Total	9.6%	28.8%	21.2%	3.8%	9.6%	1.9%	1.9%	76.9%
Count	1	2	2	0	2	1	1	9
% within LIFE SATISFACTION	11.1%	22.2%	22.2%	0.0%	22.2%	11.1%	11.1%	100.0%
% within Household Income Level (AVG per PostCode)	16.7%	10.5%	14.3%	0.0%	28.6%	50.0%	50.0%	17.3%
% of Total	1.9%	3.8%	3.8%	0.0%	3.8%	1.9%	1.9%	17.3%
Count	0	2	1	0	0	0	0	3
% within LIFE SATISFACTION	0.0%	66.7%	33.3%	0.0%	0.0%	0.0%	0.0%	100.0%
% within Household Income Level (AVG per PostCode)	0.0%	10.5%	7.1%	0.0%	0.0%	0.0%	0.0%	5.8%
% of Total	0.0%	3.8%	1.9%	0.0%	0.0%	0.0%	0.0%	5.8%
Count	6	19	14	2	7	2	2	52
% within LIFE SATISFACTION	11.5%	36.5%	26.9%	3.8%	13.5%	3.8%	3.8%	100.0%
% within Household Income Level (AVG per PostCode)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
% of Total	11.5%	36.5%	26.9%	3.8%	13.5%	3.8%	3.8%	100.0%

Appendix 26 - Multivariate Analysis – Mediation and Moderation Results

Paisley, Scotland Mediation Test

Pearson Correlation Coefficients Prob > |r| under H0: Rho=0 Number of Observations		
		Life_Satisfaction
GS_Size_Area Size - Area Characteristics	Coeff. p-value n	-0.01687 0.8313 162
GS_Density Size - Density Characteristic		-0.09530 0.2191 168
GS_Largest Size - Largest Characteristic		-0.05722 0.4809 154
GS_Shape Shape - Regulation Greeness Characteristic		-0.03834 0.6228 167
GS_Regulation Shape - Regulation		-0.04131 0.6017 162
GS_Complexity Shape - Complexity and Diversity		-0.03731 0.6384 161
GS_NN Proximity - Nearest GS Neighbour		-0.11603 0.1330 169
GS_Isolation Proximity - Isolation and Connectivity		-0.09457 0.2255 166
GS_Coherence Proximity - Level of Coherence		-0.02727 0.7396 151
GS_TotalEdge Edge - Total Edge		-0.02016 0.8104 144
GS_LongestEdge Edge - Longest Edge		-0.12891 0.1184 148
GS_EdgeDensity Edge - Edge Density		0.13870 0.0747 166
GS_LevelOfGreen Level of Green - Vegetation Composition		-0.00670 0.9313 168

Pearson Correlation Coefficients Prob > |r| under H0: Rho=0 Number of Observations	
	Life_Satisfaction
GS_Setting Level of Green - Vegetation Composition - Setting	-0.00143 0.9852 169
GS_Horizontal Level of Green - Vegetation Structure - Horizontal	-0.04349 0.5756 168
GS_Vertical Level of Green - Vegetation Structure - Vertical	-0.06010 0.4390 168
GS_V_Density Level of Green - Vegetation Structure - Density	0.13259 0.0876 167
GS_RoadProximity Level of Green - Proximity to Heavy Traffic Road	0.06987 0.3667 169
GS_Visibility Level of Green - Vegetation Structure - Visibility	0.00902 0.9073 169
GS_Cleanliness Maintenance and Management - Cleanliness	-0.07298 0.3457 169
GS_Facilities Maintenance and Management - Facilities	0.01281 0.8687 169
GS_Paths Maintenance and Management - Facilities - Paths	0.00491 0.9496 168
GS_SocialSpaces Maintenanec and Management - Facilities - Sociability	-0.06349 0.4136 168
GS_Safety Safety and Security	0.00274 0.9718 169

Vantaa, Finland Mediation Test

Pearson Correlation Coefficients Prob > |r| under H0: Rho=0 Number of Observations	
	Life_Satisfaction
GS_Size_Area Size - Area Characteristics	-0.05732 0.3997 218
GS_Density Size - Density Characteristic	0.00260 0.9713 195
GS_Largest Size - Largest Characteristic	-0.11331 0.0952 218
GS_Shape Shape - Regulation Greeness Characteristic	-0.02731 0.6885 218
GS_Regulation Shape - Regulation	-0.01935 0.7763 218
GS_Complexity Shape - Complexity and Diversity	-0.14986 0.0269 218
GS_NN Proximity - Nearest GS Neighbour	-0.00905 0.8943 218
GS_Isolation Proximity - Isolation and Connectivity	-0.04100 0.5480 217
GS_Coherence Proximity - Level of Coherence	-0.11999 0.0771 218
GS_TotalEdge Edge - Total Edge	-0.07483 0.2713 218
GS_LongestEdge Edge - Longest Edge	-0.06418 0.3479 216
GS_EdgeDensity Edge - Edge Density	-0.11005 0.1068 216
GS_LevelOfGreen Level of Green - Vegetation Composition	-0.11304 0.0975 216
GS_Setting Level of Green - Vegetation Composition - Setting	-0.09165 0.1796 216

Pearson Correlation Coefficients Prob > |r| under H0: Rho=0 Number of Observations	
	Life_Satisfaction
GS_Horizontal Level of Green - Vegetation Structure - Horizontal	-0.14362 0.0349 216
GS_Vertical Level of Green - Vegetation Structure - Vertical	-0.08934 0.1909 216
GS_V_Density Level of Green - Vegetation Structure - Density	-0.07563 0.2684 216
GS_RoadProximity Level of Green - Proximity to Heavy Traffic Road	0.07523 0.2710 216
GS_Visibility Level of Green - Vegetation Structure - Visibility	0.05347 0.4343 216
GS_Cleanliness Maintenance and Management - Cleanliness	0.03637 0.5950 216
GS_Facilities Maintenance and Management - Facilities	0.02292 0.7377 216
GS_Paths Maintenance and Management - Facilities - Paths	0.08461 0.2155 216
GS_SocialSpaces Maintenanec and Management - Facilities - Sociability	0.01923 0.7787 216
GS_Safety Safety and Security	0.07071 0.3009 216

Paisley, Scotland Moderation Test

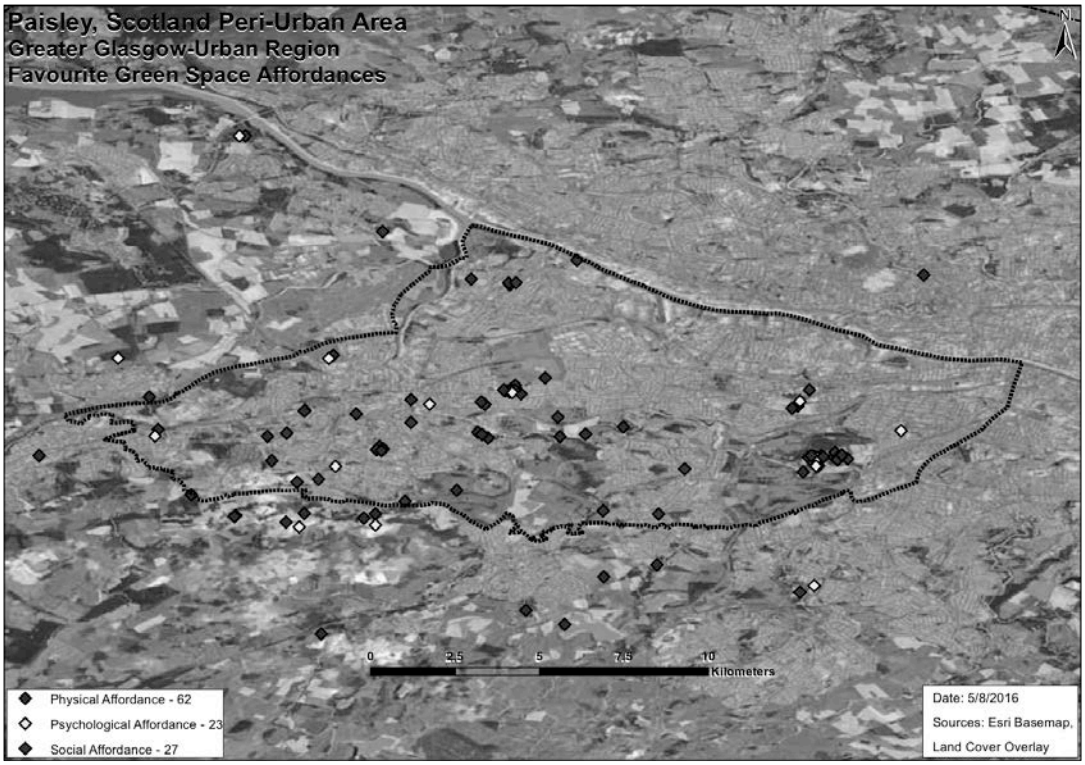
Pearson Correlation Coefficients Prob > |r| under H0: Rho=0 Number of Observations		
		Life_Satisfaction
Age Respondent's Age	Corr. p-value n	-0.09973 0.5000 48
Gender Respondent's Gender		0.02913 0.8442 48
Depravity_Quintile_Ranking Depravity Quintile Ranking Scores		-0.04375 0.7678 48
AVG_Household_Income Household Income Level (AVG per PostCode)		-0.10449 0.4797 48
AVG_Education_Level Education Level (AVG per PostCode)		-0.17734 0.2279 48

Vantaa, Finland Moderation Test

Pearson Correlation Coefficients Prob > |r| under H0: Rho=0 Number of Observations		
		Life_Satisfaction
Age Respondent's Age	Corr. p-value n	-0.01105 0.9380 52
Gender Gender		0.19914 0.1570 52
Depravity_Quintile_Ranking At Risk of Poverty Threshold Ranking		. . 52
AVG_Household_Income Household Income Level (AVG per PostCode)		0.07262 0.6089 52
AVG_Education_Level Education Level (AVG per PostCode)		-0.03625 0.7986 52

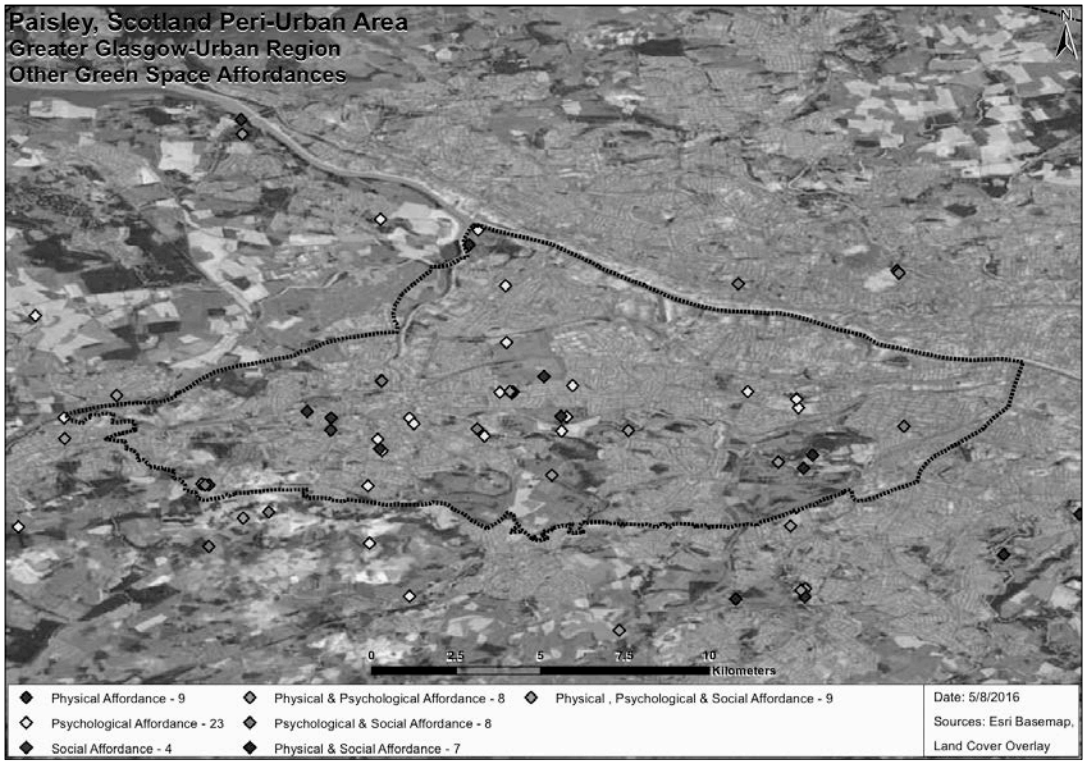
Appendix 27 - Descriptive Analysis Results - Geospatial Mapping of HWB and FGS / OGS

Paisley, Scotland CA



Highest frequency selections of FGS to visit:
n=85
18.8% of respondents (n=16) listed Pollock Park as FGS.
12.9% of respondents (n=11) listed Barshaw Park as FGS.
5.5% ofs (n=10) listed Brodie Park & Glennifer Braes – Robertson as FGS.

Figure A27.1: FGS Affordance Locations
Paisley, Scotland Catchment Area



Highest frequency selections of OGS to visit:
5.5% of respondents (n=3) listed Glennifer Braes – Robertson Park, Rouken Glen, Bellahouston Park, Brodie Park and Barshaw Park as OGS.
3.6% of respondents (n=2) listed Pollock Park, Linwood Lade, and Saucehill Park as OGS.

Figure A27.2: OGS Affordance Locations
Paisley, Scotland Catchment Area

Of the total 104 individual OGS markers provided by the respondents (See Figure A37-8), 9 of those were noted as providing all three HWB benefits. As noted prior, the FGS geo-marker did not provide multiple benefits as a qualitative aspect of the data collection during the survey-questionnaire, only the OGS geo-marker. As such, 8.6% of OGS markers provided the full range of HWB benefits – Physical, Social and Psychological.

Multi-Functional GS:
Rosshall Park, GS near Morrisons and Black Cart Water (Linwood), GS near Foxbar Rd., Barshaw Park, Rouken Glen

Of the 9 total synergistic or multi-functional GS, the following two (2) were both a singular selected GS which were geo-marked by a singular (n=1) respondent as an OGS providing all three different HWB benefits to that individual:

GS near Morrison's and Black Cart Water (Linwood)

Rosshall Park

These results suggest the OGS likely provides a comprehensive set or multiple HWB benefits to that individual alone and is not necessarily representative of comprehensive or all three affordances to the larger population. There were some eco-spatial characteristics shared among these 9 multi-functional HWB GS:

Structural Characteristics

Size Characteristics
A GS in the region which provides an extensive area and high density to block views to housing or human development

Shape Characteristic
A GS of moderate shape and regulation, complexity in shape was evenly shared among GS

Proximity Characteristics
A primarily physically connected to another GS and part of a larger group and are in close proximity to a road.

Edge Characteristics
A GS with moderate edge length and dense edges wehre the GS edge makes it not very visible into green structure and blocks views into green structure

Level of Greenness Characteristics
4 of these 6 GS are considered Parks and include vegetation characteristics in a semi-natural GS setting with diverse and random horizonal vegetation yet variable vertical vegetation structure.

Maintenance and Management Characteristics
3 of the 6 GS are considered moderately clean with abundant facilities.

Safety and Security Characteristics
4 of the 6 GS are considered somewhat safe with high sociability.

Non-Structural Characteristics
These GS were most often Publicly accessible.

Lastly, the following three OGS were marked multiple times as providing all 3 HWB benefits with their frequency noted:

Barshaw Park,	*n=3*
GS near Foxbar Rd	*n=2*
Rouken Glen	*n=2*

The eco-spatial characteristics for all three of these OGS are not considered

similar resulting in association to HWB benefits inconsistent. Interestingly, two are Park typologies and the other is an unnamed GS near a river/stream and housing developments. Only a few of their structural eco-spatial characteristics are shared among all 3 such as Close proximity to road, High sociability of their GS, and a Moderate length to their Edges.

Within the non-structural characteristics, only Rouken Glen carries a special designation to it and all are considered publicly accessible. Additionally, only Rouken Glen is out of the CA.

All 3 of these OGS are located within further away from Downtown Glasgow and the River Clyde and all have a water presence in the such as a river or stream or pond/lake. Geomorphologically, this result would indicate significant advantage of water in providing a comprehensive suite of HWB benefits. However, eco-spatially, these OGS indicate some important characteristics that potentially provide the inclusive set (i.e. all 3 HWB Affordances) of HWB benefits to the population:

Structural Characteristics

Size Characteristics

66% are of the largest GS in the region which provides an extensive area and high density to block views to housing or human development.

Shape Characteristic

2 of the 3 (66%) GS are irregularly regulated GS and are of a moderately complex shape (4-8 sides).

Proximity Characteristics

All are physically connected to another GS (or water) and not isolated from but integrated with other and considered within a group of GS in the area and all are close to roads.

Edge Characteristics

66% contain moderately numbered and moderately lengthed edges to them (4-8) which are often dense either by vegetation or other structures to block or limit views into the GS.

Level of Greenness Characteristics

Incorporate mostly (66%) deciduous vegetation within a varied (i.e. natural or urban) setting whose open uniform horizontal and diverse and random vertical vegetation is mostly open when within the GS providing many views within the GS.

Maintenance and Management Characteristics

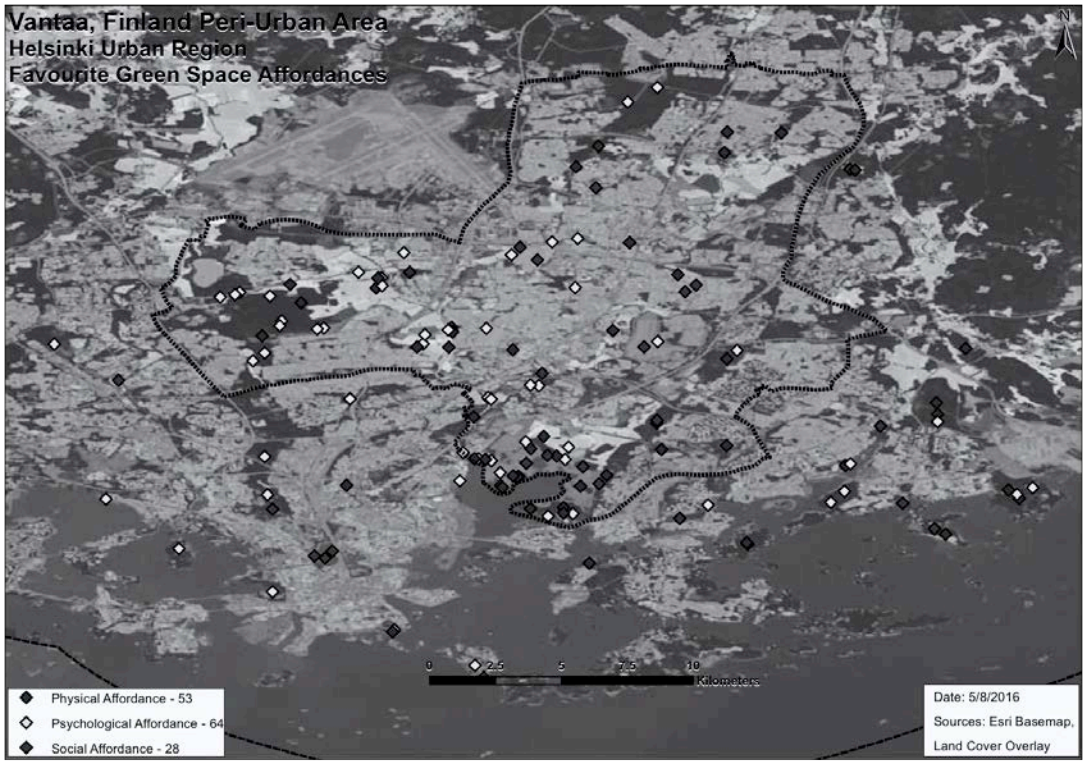
66% include moderately clean GS not considered tidy with only moderate maintenance and management. Paths within the GS are predominately paved and an abundant amount of facilities and user amenities such as drinking fountains, trash bins and bathrooms exist. There is high sociability

within the GS providing for a variety of group and isolated spaces with many benches and tables.

Safety and Security Characteristics
Each GS provided a different level of Safety and Security.

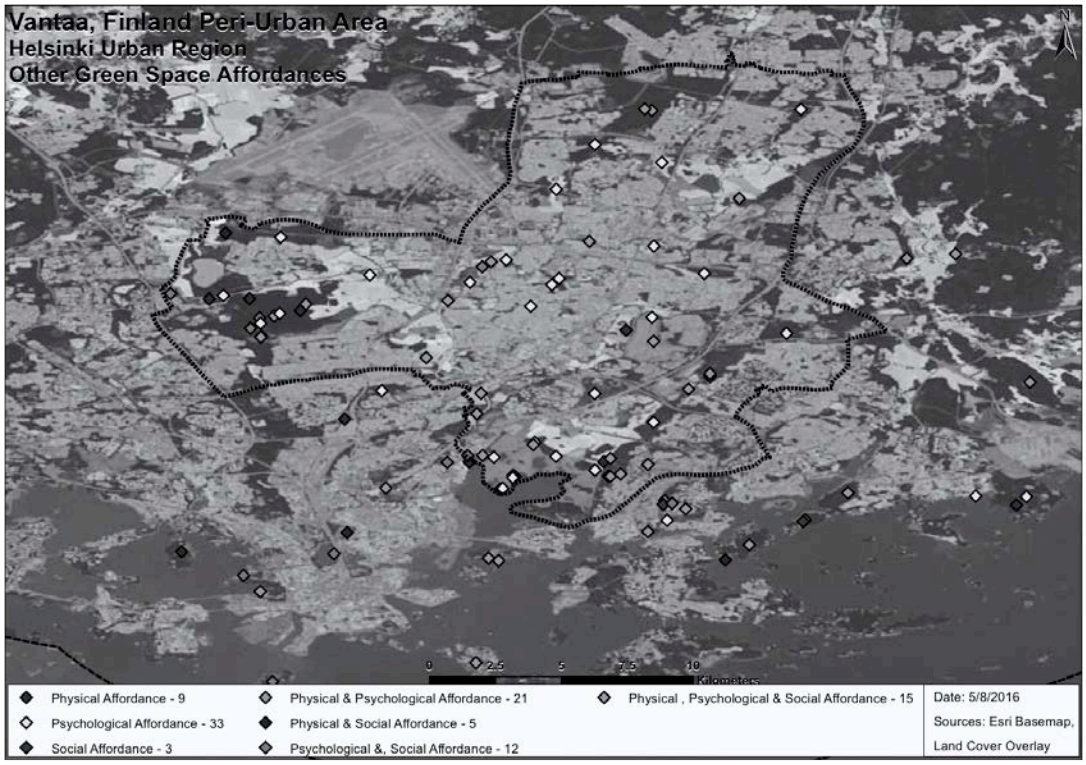
Non-Structural Characteristics
33% included Special Designation
All were Publicly Owned
66% included a title to them (e.g. Central Park)
66% Park GS typology
Travel long distances to get to them (over 2K)
Travel to these GS by various means including walking and biking, with car or bus being a very small amount of visits.

Vantaa, Finland CA



Highest frequency selections of FGS to visit:
11.4% of respondents (n=28) listed Lamasaari Island as FGS.
6.1% of respondents (n=15) listed Paloheina Woodlands as FGS.
3.7% of respondents (n=9) listed Fastholma Green Space as FGS.

Figure A27.3
FGS Affordance Locations
Vantaa, Finland Catchment Area



<u>Highest frequency selections of OGS to visit:</u>
10% of respondents (n=10) listed Lamasaari Island as OGS.
10% of respondents (n=10) listed Paloheina Woodlands as OGS.
3% of respondents (n=3) listed Fastholma Green Space as OGS.

Figure A27.4
OGS Affordance Locations
Vantaa, Finland Catchment Area

Of the total 102 individual OGS markers provided by the respondents (See Figure A37-x), 15 of those were noted as providing all three HWB benefits. As noted prior, the FGS geo-marker did not provide multiple benefits as a qualitative aspect of the data collection during the survey-questionnaire, only the OGS geo-marker. As such, 15% of OGS markers provided the full range of HWB benefits – Physical, Social and Psychological. These GS are considered the 'big-hitters' and require further analysis and discussion.

Of the 15 total synergistic or multi-functional OGS, the following nine (9) were both a singular selected OGS which were geo-marked by a singular (n=1) respondent as an OGS providing all three different HWB benefits to that individual:

Kaivopuisto Park
GS in Annala
Mustikkamma Island
Urban Park near Pengerpuisto
Filbunken Beach
GS near Roihuvuori

GS near Herttoniemi Hosptial
GS near Roihupelto
GS near Tammisto

These results suggest the OGS likely provides a comprehensive set or multiple HWB benefits to that individual alone and is not necessarily representative of comprehensive or all three affordances to the larger population. There were some eco-spatial characteristics shared among these 9 multi-functional HWB OGS:

Structural Characteristics

Size Characteristics
A GS in the region which provides a moderate to extensive area to block views to housing or human development but also allows views to other GS nearby.

Shape Characteristic
There were no Shape characteristics of note shared similarly among these GS of note (>66%)

Proximity Characteristics
A primarily physically connected to another GS.

Edge Characteristics
There were no Edge characteristics of note shared similarly among these GS of note (>66%)

Level of Greenness Characteristics
4 of these 9 GS are considered grasslands and include uniform horizontal vegetation characteristics in an urban (n=5) or semi-urban (n=2) GS setting.

Maintenance and Management Characteristics
8 of the 9 GS are considered clean.

Safety and Security Characteristics
7 of the 9 GS are considered safe.

Non-Structural Characteristics
There were no non-structural characteristics of note shared similarly among these GS of note (>66%)

Additionally, the following GS were selected by three (n=3) different respondents as a FGS providing one of each of the three different HWB benefits:

Central Park – Laakso & Ruskeasuo Section
Kivinokka Green Space

This result suggests these two FGS potentially provide a comprehensive set of HWB benefits to other individuals and could be representative of a comprehensive affordance based GS to the larger population. The eco-spatial characteristics of these

two FGS are quite similar. Both are considered larger parks and public GS, both are physically connected to other GS, Kivinokka is often considered part of the Lammaassaari Island GS. Overall, both of these FGS are not considered existing within a fragmented state.

Lastly, the following four OGS were marked multiple times as providing all 3 HWB benefits with their frequency noted:

Lammassaari Island	*n=10*
Meri-Rastila GS	*n=3*
Vartiosaari Island GS	*n=3*
GS along Vantaa River	*n=2*

The eco-spatial characteristics of three of the four OGS are quite similar. Lammassaari Island, Meri-Rastila GS, and Vartiosaari Island GS are considered larger, public parks with a special landscape designation to them. All three include significant amounts of coastline and are physically connected to other GS; Meri-Rastila GS and Vartiosaari Island GS are often considered the same by GS, however these two are not within the requested CA for the survey-questionnaire, though still within the polycentric morphology of the region. All three OGS are in close proximity to one another though not physically contiguous as they are separated by a major highway and an industrial/commercial area. Interestingly, they have 3 different typologies, though some of their structural eco-spatial characteristics are similar such as Size- Area, Moderate Density and Shape Complexity, and Grouped and Integrated with other nearby GS. Overall, these OGS are not considered existing within a fragmented state when compared to the other GS within the Region.

The last of the four OGS, the GS along Vantaa River, is a linear green corridor that varies in width but includes a few eco-spatial characteristics the other 3 do not have:

Paved pathways
High sociability
Abundant Facilities
Extensive Visibility
Very clean
Moderate road proximity
Semi-natural vegetative setting
Moderate edge density
Non-special designation

The non-structural eco-spatial characteristics may be explained by the

typology, special designation, and/or setting of the OGS, as green corridors are often less-natural than parks and other grassland typologies with a special designation to them.

All 4 of these OGS are located within the southern portion of the OGS and all are contiguous to the many water-based rivers, bays, and inlets of the coastline. Geomorphologically, this result would indicate significant advantage of water in providing a comprehensive suite of HWB benefits. However, eco-spatially, these OGS indicate some important characteristics that potentially provide the inclusive set (i.e. all 3 HWB Affordances) of HWB benefits to the population:

Structural Characteristics

Size Characteristics

One of the largest GS in the region which provides a moderate GS area to block views to housing or human development but also allows vies to other GS nearby.

Shape Characteristic

A naturally-regulated GS which feels wild and natural of a moderately complex shape (4-8 sides).

Proximity Characteristics

A physically connected to another GS (or water) and not isolated from but integrated with other GS in the area.

Edge Characteristics

Contain numerous edges to them (8+) which are often dense either by vegetation or other structures to block or limit views into the GS. The length of the edges do not seem to impact HWB benefits provided.

Level of Greenness Characteristics

Incorporate mixed deciduous and coniferous vegetation within a distinctly natural setting whose horizontal and vertical vegetation is mostly diverse and random, not uniform and clumped, and the visibility is limited by the vegetative structure of the GS. The density of the vegetation, overall, did not seem to impact HWB benefits provided,

Maintenance and Management Characteristics

Include moderately clean GS not considered tidy with only moderate maintenance and management. Paths within the GS are predominately unpaved and only a limited amount of facilities and user amenities such as drinking fountains, trash bins and bathrooms exist. Most of the GS is limited in social spaces, and include the mostly solitary and isolated spaces with only a few or no benches or tables.

Safety and Security Characteristics

Somewhat safe GS with some lights and some open edges open with acceptable visibility at some places.

Non-Structural Characteristics

Special Designation
Publicly Owned
Not require a title to them (e.g. Central Park)
Park or Woodland/Grassland GS typology
Travel long distances to get to them (over 2K)
Travel to these GS by various means including walking and biking, with car or bus being a very small amount of visits.