SOCIAL AND ENVIRONMENTAL DETERMINANTS OF QUALITY OF LIFE:

THE CASE OF GLASGOW

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Abstract

Quality of Life (QoL), or the lack of it, is considered one of the major social problems in the UK; Scotland and Glasgow are particularly affected by it as the 2007 Glasgow Economic Audit reported that 47% of the population lived in the most deprived 15% of areas of Scotland, areas which present some of the poorest outcomes in western Europe for child poverty, health, crime, alcohol and drug abuse (Forum, 2007).

Urban design and town planning are infrequently at the centre of any policy aimed at improving Quality of Life, or lessen deprivation, as it is conceptualized and measured in Scotland; often housing policies are the only ones where architecture plays a main role, but low Quality of Life, or deprivation, is a phenomena spread across the urban environment and not confined to the debate on housing policies.

This thesis investigates Quality of Life in relation to its Social and Environmental determinants and in particular in relation to Urban Form, focusing on how a few key features of urban form correlate spatially to several indicators of Quality of Life.

The study focuses on how aspects of QoL can help understanding the role of urban form and concludes that urban form itself should be introduced as an indicator in the multileveled indexes developed to measure QoL.

With the adoption of a configurational morphological approach this study brings the focus on the assessment of performance of different urban configurations, through the application of centrality approaches which allow consistent links to behavioural impacts of the urban spatial structure (Krafta, 1994).

Results show that the configurational approach, theory and tools contribute to a more subtle understanding of the role of space in the built environment, both at a large metropolitan scale and at a small neighbourhood/street scale, as well as being able to highlight essential differences between neighbourhoods in relation to the city in its entirety.

Using Glasgow as a case study, this thesis finds that the distribution of space has a significant influence on social outcomes, which can at times, and depending on circumstances, be strengthened or moderated by it.

Positive and negative social connotations of space configuration in Glasgow are identified and although it is not possible to say that low QoL or deprivations are a direct consequence of space configuration, we can safely argue that spatial properties play an important role in the process.

The role of the structure of the built environment has often been overseen in discussions on QoL; if it can be demonstrated that urban form can have an effect on certain aspects of public life such as accessibility to other people and facilities, pedestrian and vehicular traffic flows, co-presence in public space, and movement patterns, then it can be confirmed that the shape of the built environment is able to directly influence people's behaviour.

Increasing Urban Quality of Life (UQOL), or lessening deprivation, are very high priority on the Scottish Government agenda and the understanding that urban form has a discernable impact on people's behaviour, opens for the prospect of addressing such issues through urban design led policies.

The outcomes of this thesis widen the opportunity of adopting urban design as a fundamental competence within the set of initiatives aimed at increasing Quality of Life and lessening deprivation.

Contents

1. Introduction

1.1. Background to the subject matter

For urban settlements in the UK, and in Scotland in particular, areas with poor levels of Quality of Life are a major social concern as they often indicate that living conditions, access to services and to the labour market are not equally distributed.

In general terms in the past decades socio-economic segregation has been rising in the UK as a consequence of higher levels of social inequality (Dorling et al., 2007). Rising of segregation is widely acknowledge as problematic due to the link to the "neighbourhood effect", that is the negative impact on individuals welfare and economic efficiency that derives from living in neighbourhoods with high levels of Deprivation (or low levels of Quality of Life) (Van Ham et al., 2013).

The problem of inequalities has been the focus of the UK government's Social Exclusion Unit established in 1997, whose 'National Strategy Action Plan' for neighbourhood renewal published in 2001 has as a core objective that "within ten to twenty years, no-one should be seriously disadvantaged by where they live" (Unit, 2001).

Physical separation between groups in society can result in social distance between different populations (e.g.: differences between social groups in terms of class, income, education etc.); as a consequence, some groups are separated from fundamental parts of everyday life such as access to education, cultural facilities, the labour market, etc.(Buck, 2001) as well as the the wider networks of civic life (Schönfelder et al., 2003).

The concept of segregation is inherently spatial, an individual or a group being physically distant from somewhere or something, but the role of space into anti segregation policies is not often taken into account.

In cities especially, the physical separation between groups is closely linked to the configuration of the built environment and therefore a matter for consideration in urban design and planning policies.

Notwithstanding the evidence of the role of space, historically policies involving the built environment aimed at increasing QoL or diminishing Deprivation have often concentrated exclusively on social housing matters.

A first sign of change of direction in the acknowledgment of the influence of space on everyday lives in the UK came from the New Labour Government which 1997 put cities at the core of its agenda, and has been since championing a variety of new initiatives in neighbourhood renewal, including the commissioning of the Urban Task Force report "Towards an Urban Renaissance" published in 1999 (Force, 1999). The report examined the idea of building 4 million new homes in 25 years without using any of the green belt or unbuilt areas of countryside, and although the attention was still on the housing matter, then report recommended that urban regeneration should be design led, able to improve social well being, focused on social responsibility and supported by a viable economic and legislative framework.

Building on this, The Scottish Government in 2013 published two seminal policy documents, Designing Places and Designing Streets, which frame a complete new approach to the improvement of QoL focusing on high quality design and place making, together with a further policy document which links place to health, Good Places, Better Health.

A formal link between QoL, Deprivation, Segregation and Urban Form has yet to be acknowledged by any governmental policy.

Does the urban environment present certain spatial qualities able to enhance or reduce QoL?

What is the role of urban form in enabling active public spaces encouraging social encounters and mixing?

This thesis will investigate approaches, methods, analysis and tools, which seek to explore the implications that the built environment has for the social welfare of people in cities, neighbourhoods and streets.

In the following section we will explore the relationship between society and space, or urban space, and how it is empirically expressed.

1.2. Research justification

A city can be perceived on two levels, a physical one, as a large group of buildings linked by space, and a social one, as a system of human activities linked by interaction. In order to investigate the relationship between space and society the city has to be considered in its entirety, as an entity which is both physical and social (Hillier et al., 2007).

Many of the predominant definitions of QoL, Deprivation or Segregation present a one sided approach which leaves little space to matters of Urban Design and considerations on the specific role played by urban form.

A spatial approach, if framed within a rounded theory of space as an entity of social significance, will on the contrary support a stronger emphasis on the built environment itself (Legeby, 2008).

This could also result in the recognition of the importance of evaluating the externalities of an active public life through the idea that interplay segregation (levels of interaction between people in urban life), an aspect often forgotten in anti Deprivation policies, is in fact as important as social segregation (Legeby, 2009).

The UK National Strategy Action Plan for neighbourhood renewal published in 2001 clearly states that citizens have a right to equal living conditions (Unit, 1998).

An important contribution to the debate of how urban design and planning decisions can contribute to the achievement of an equal distribution of resources is given by a study developed by Julienne Hanson which relates urban design concepts to preconditions to sociability (Hanson et al., 1987) (Hanson, 2000).

In "Urban transformations: a history of design ideas" Hansons examined the morphological transformations that have taken place during the course of 100 years in the design of housing in Somers Town, a small inner London neighbourhood. The neighbourhood changed from a series of very similar streets to a number of very different housing estates where the spatial distribution between building and entrances, building and streets, as well as between neighbourhoods had been completely altered. The study highlights how the new set of spatial relationship dictated by the newer modernist layouts was at all conducive to less interactions between close neighbours, or indeed, between adjacent neighbourhoods, and thus how the chances for local and not local residents to mix had decreased, with a significant reduction of the potential for a vibrant and successful urban life.

It is of fundamental importance for Planners, Urban Designers, Architects and policy makers to explore which aspects of the built environment are able to influence public life, and how.

The role of the configuration of space has been largely neglected in the discussions on QoL, Deprivation or Segregation, and this thesis aims to demonstrate that this gap should be addressed.

The configuration of space dictates how people are connected through public space and how buildings and neighbourhoods relate to one another.

By establishing that urban form is able to influence movement flows, accessibility to other people in public space and to fundamental civic life functions, it will be confirmed that urban form has a direct influence on citizen's lives (Olsson Hort, 1994).

This would allow issues such as QoL, Deprivation, Segregation to be investigated under an urban design point of view; findings could result in a new generation of planning policies able to incorporate the all-important role of space configuration for QoL.

It is important to stress that concepts such as Quality of Life or Deprivation are multileveled, and to be addressed effectively they require a multidisciplinary approach, which explores every aspect of them, from the social to the economical or the environmental point of view.

However, if we consider segregation, especially in the urban context in relation to neighbourhoods and neighbourhood effect, to be one of the main triggers for low levels of QoL or Deprivation (Murie et al., 2004) (Van Ham et al., 2013) , we cannot ignore the strong spatial aspect associated with it.

When then focusing on the built environment, under an urban design or planning point of view, physical space becomes an unmissable piece of the jigsaw.

The concept of segregation implies separation in space, both of people and activities; this separation happens on two levels, a social one, and a physical one; the latest, especially in the urban context, takes place in the space shaped and structured by the built environment.

What does spatial mean in social segregation? According to Mats Franzen " [...] if people and activities are of different kinds, space can be supposed to be implicated in not only the reproduction, but, and also more importantly, in their constitution" (Franzén, 2009).

Franzen highlights how social categories and social activities are embedded in space, and therefore they are spatial phenomena, as well as social phenomena and claims that research has to focus on the interaction between the social and the physical aspect of cities.

This thesis will explore how different methods and tools can be adopted to explain how the structural characteristics of the built environment are able to influence QoL.

Cities cannot be considered as static objects, they are in continuous evolution through time, streets are added, new blocks are created, old blocks are demolished, new entrances are created to old buildings, new preferred paths appear with land uses changes. All these changes influence and at the same time reflect the way people use the city, in a continuous circle of cause and effect.

For urban designers, planners and policy makers alike, it is of fundamental importance to understand and perceive the city as a complex physical system in order to predict the possible social outcomes of every decision taken in relation to the structure of the built environment.

If the structure of the built environment has the capability of enhancing sociability thus diminishing segregation, it would be a major fault not to consider it as a major factor in the battle against deprivation, or in the effort to improve QoL.

We can describe cities as complex systems constituted by different layers which, a bit like in a cad drawing (and here I am revealing my architectural background!), are positioned one on top of each other, and have to coexist in order to provide all the necessary information at a glance, but can also be switched on and off to give the designers the opportunity to focus on different aspects. Continuing with the analogy, we could think of a structural layer containing streets and open spaces, a built level, containing buildings, an environmental layer with green spaces, and certainly a series of social, historical and cultural layers.

Traditionally research on Quality of Life, Deprivation, Segregation or similarly defined indexes, focused on the social layers adopting indicators such as employment, income, health levels, etc.; while research on the built environment, especially if addressed with an urban morphology background, concentrates on the description of the built environment itself, adopting mainly urban elements and typologies indicators.

This thesis will attempt to bring the two approaches together, as our specific interest

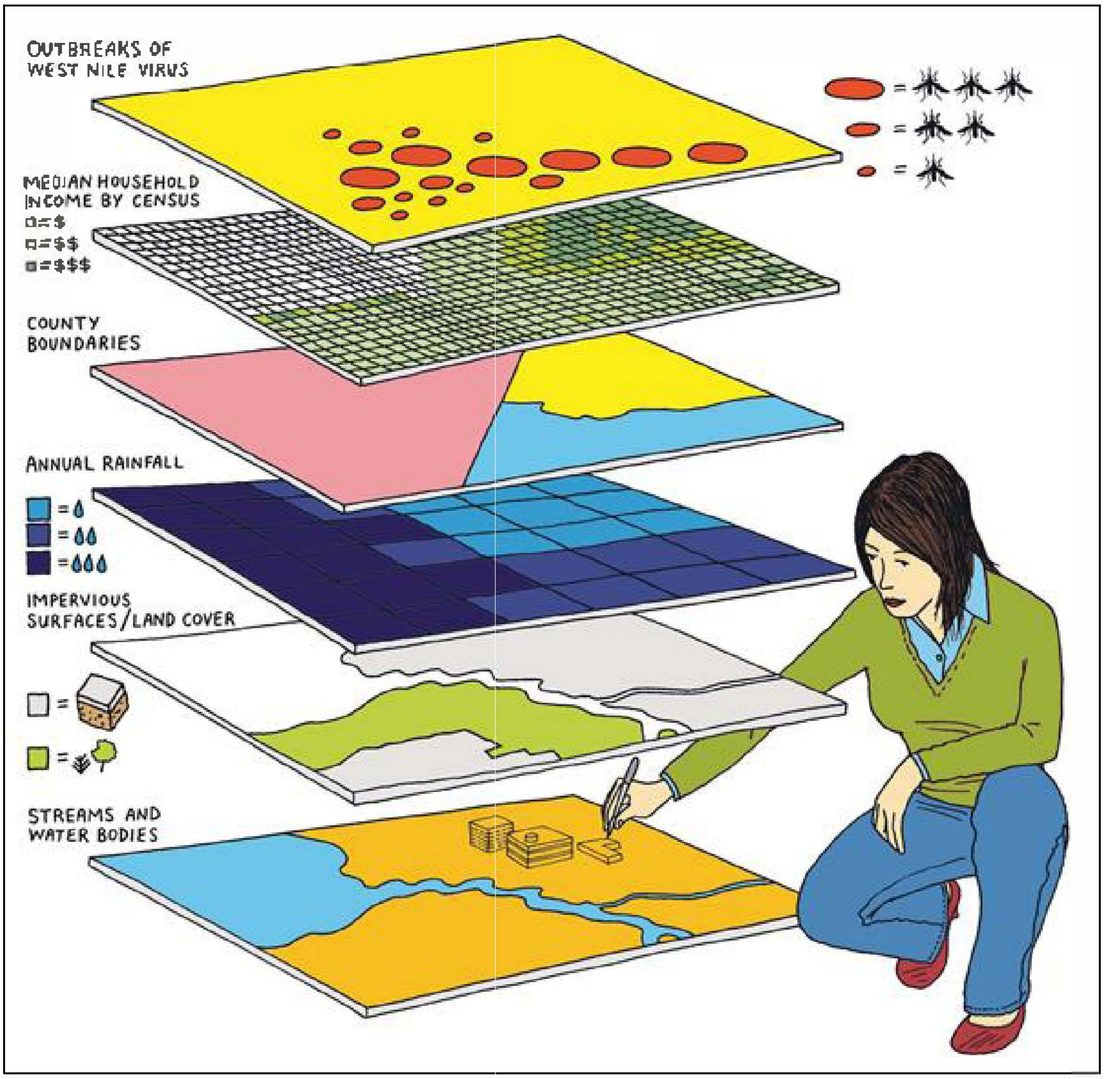


Figure 1. Cities can be regarded as complex systems constituted of different layers; Esri, the company behind ArcGIS, the most popular Geographic Information System software, has invented a new term, geodesign, which can be loosely defined as the integration of geographic analysis and tools into the design process (Zeigher, 2010) (Source: http://www.esri.com/)

lies on how urban form is able to influence social outcomes.

We argue that urban form is the layer able to link social layers and built layers and allow us to analyse both sets of layers as whole, rather than in isolation.

Jan Gehl encourages us to focus on people and activities rather than buildings (Gehl, 1980); investigating the behaviour of people in relation to the built environment will lead to a better understanding of the physical prerequisites able to facilitate such behaviours.

To analyse the impact of urban form on social outcomes this thesis adopts a configurational approach, shifting the approach from spatial location to spatial relation. Departing from the existing research on Quality of Life and Deprivation which focuses on the distribution in space, this thesis focuses on the distribution of space (urban form) and the distribution through space (urban flows) (Marcus, 2008).

To clarify, we can further expand on the three forms of distribution:

1. Distribution in space: where social categories of people or services are

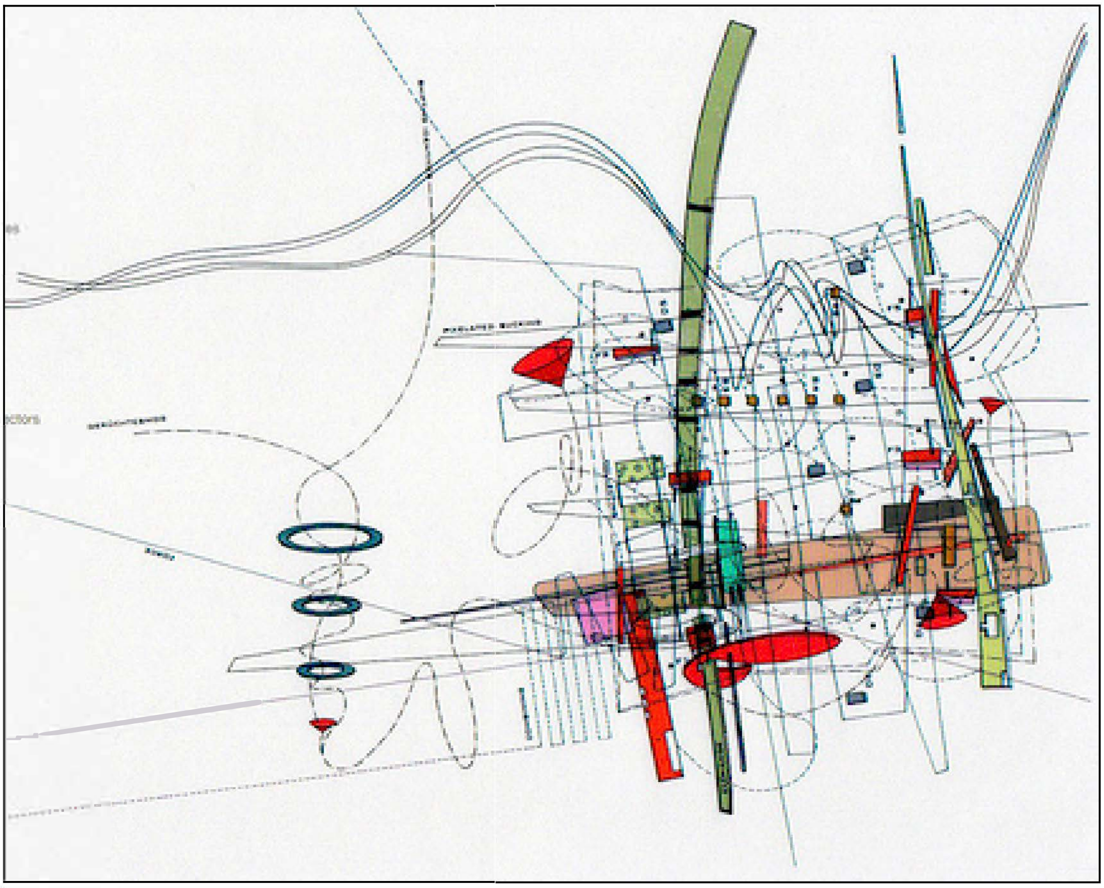


Figure 2. You are the City: Observation, Organization and Transformation of Urban Settings; "The diagram is one of the only mechanisms by which conventional thinking about cities can be located and dislodged. The diagram is where conventions, givens, are wrestled with ... Kempf uses abstraction, aggregation and overlay to subvert the conventional urban plan." (Source: Catherine Ingham in Cities of Substance, Cities of No Substance, (Kempf, 2009))

distributed in the built environment

2. Distribution of space: how space is shaped and formed by the built environment (built form)

3. Distribution through space: what happens in space as a consequence of the sum of what is in the environment and its structural configuration.

This thesis analyses the relationship between certain aspects of QoL and urban form through a configurational approach in order to provide insight for urban designer and policy makers on the role that space distribution can play in the functioning of cities.

1.3. Aims and objectives

This research mainly investigates how concepts like QoL, Deprivation, Segregation or the many permutations of similar multileveled constructs can be conceptualized, analysed and described in a manner capable of increasing valuable and significant knowledge from an urban design point of view.

Two main criteria are fundamental to this research:

1. Cities have to be examined as a whole; neighbourhoods, urban blocks or streets have to be analysed within their context, and not in isolation, since spatial systems, or networks, are continuous, and local changes can have global consequences (Brandberg, 1999) (Porta et al., 2010)
2. Urban space has to be analysed as an entity in itself through a set of theories, methods and tools able to measure various spatial factors affecting human life in cities (Scellato et al., 2006)
3. The following main concerns are addressed:
4. How are concepts like QoL, Deprivation, Segregation, etc. described in the existing literature and what is the role of space configuration?
5. Are Scottish Policies considering the role of space configuration when addressing issues like QoL, Deprivation, Segregation, etc.?
6. How can multileveled concepts such as QoL, Deprivation, Segregation, etc.

be reviewed in order to increase the role of Urban Design in the actions to address them? Can urban systems be analysed according to their outcomes on QoL, Deprivation, Segregation, etc.? Would it be possible to describe the potentials or downsides of different urban forms through a comparison of neighbourhoods assisted by socio economic statistics?

If it can be demonstrated that urban form can affect peoples behaviour (Dempsey et al., 2010) then Urban Design is an essential tool that has to have a greater role in anti deprivation initiatives which could lead to a wider debate on urban sustainability, both in case of regeneration of the existing city or new planned expansion.

1.4. Research methodology

The research methodology adopted for this study is introduced in this section, and how it has guided data collection, analysis and development of theory.

Data collection and analysis approach for empirical data will be explained in greater depth in the methodology section dedicated to each case study (“6.3. Town Centres and Centrality Indexes” on page 207, “6.4. Commerce and rental values distribution in Glasgow” on page 244, “6.5. Methadone prescriptions as a proxy indicator of deprivation in Glasgow” on page 268).

This thesis seeks to utilise qualitative and quantitative approaches in order to test the hypothesis, as outlined in chapter “1.3. Aims and objectives” on page 26, that there is a measurable relationship between the spatial configuration of the street system and the spatial pattern of proxy indicators of Quality of Life; this research aims to provide a robust argument towards the introduction of more urban design based solutions in governmental policies on regeneration, urban renewal and social integration.

Decisions about public service development and reform are supported by analysis of quantitative data and as such the methodology for this research is designed to produce a quantitative output (Morton et al., 2015)

In urban design, since the mid 1970s, Space Syntax has developed a quantitative approach based on geospatial computer technology for the analysis of spatial configuration of urban settlements, linking urban form to movement patterns, spatial segregation and social disadvantage, as well as other socio economic indicators (Hillier et al., 1993).

Space syntax based research offers evidence-based foundations that a strong correlation exists between indexes of space configuration and socio economic indicators and has provided powerful conceptual and empirical support for Jacobs' more intuitive claim that the physical-spatial environment plays an integral part in making active streets and an urban sense of place (Jacobs, 1961).

For example, in the case of the location of commerce and services at the neighbourhood scale, an issue at the heart of Jacobs critique and an indicator of street vitality (Balsas, 2004), SS research had demonstrated that the topological configuration of urban streets has strong influence on the location of commercial centers (Fan et al., 2011).

More recently, different tools for the development of quantitative analysis of urban environments have been developed, such as the Multiple Centrality Assessment and the Urban Network analysis.

The different tools enable a quantitative approach to research on urban configuration and its correlation with how people experience and navigate systems of streets and intersections.

For the scope of this research, it was felt that the approach developed by MCA was preferable to:

- Space Syntax, as it its primal graph allows to retain metric distances (Porta et al., 2006), (even if since the introduction of MCA, Space Syntax has effectively been developed further to include a proper network analysis based on primal road centerline network data and "angular segment analysis" (Turner, 2007)), and are of easier interpretation as they retain the shape of the urban network;

- and to the Urban Network Analysis as the MCA tool is based on a open source platform which is not directly aimed at being commercialized and allows for a greater degree of customization by the user (see "Multiple Centrality Assessment (MCA)" on page 142).

The adoption of the MCA as a tool allowed for the development of quantitative indicators on urban form which could be analysed in relation to proxy indicators of QoL.

Proxy indicators of QoL have been chosen according to two parameters:

- Relevancy: an indicator was considered adoptable as a proxy if existing literature review indicated that it had been adopted as a variable in previously developed indexes of QoL.
- Availability: indicators have been chosen if available at the scale required for the correlation analysis (address scale). Indicators which were relevant, but not available at the right scale, have been evaluated qualitatively.

Glasgow City Council and the Scottish Assessors Association were the main sources of the data included in this research (see "5. Introduction To The City Of Glasgow And

Method of Analysis" on page 172).

The possible correlations between urban form indicators and proxy indicators of QoL will be explored through the development of two categories of case studies set in Glasgow, based on a quantitative as well as a qualitative approach. The quantitative approach will not be applied across all the case studies due to unavailability of relevant socio economic indicators at the scale necessary for the investigation.

In the case of the quantitative analysis it is important to stress that the street network with centrality values and the distribution of economic activities, as well as the variation of rateable values are two distinct spatial features, and as such the transformation in a single consistent unit of analysis was required to analyse their relationship.

In GIS, a Kernel Density Estimation is performed on both street centrality and economic activities to obtain two raster datasets with the same resolution and thus permits the analysis of relationship between them (correlation analysis) (Porta et al., 2007).

In the case of the qualitative analysis instead, centrality indexes have been visually evaluated in light of the Scottish Index of Multiple Deprivation.

As mentioned at the beginning of this section, each case study will present a more in depth discussion on the methodology developed, as, while the approach remains consistent throughout the study, each case presents its singularities in the gathering and analysis of the data.

1.5. Research design

This section describes the outline structure and research design of the dissertation. developed to answer the research questions discussed in section 1.4 (Figure 3).

The relationship between the built environment and Quality of Life will be investigated through the study of the relationship between urban form and proxy indicators of Quality of Life.

Centrality indexes will be adopted as urban form indicators and will be calculated through the Multiple Centrality Assessment developed by Porta et al (Porta et al., 2010). Proxy indicators of Quality of Life will be correlated to urban form indicators (developed through the MCA) to investigate the possibility of a correlation between the variables. Quality of life indicators are categorized as positive when associated with positive social outcomes, and vice-versa; for example presence of services and commercial activities are associated with street vitality (Jacobs, 1961) ,while a high presence of methadone prescriptions is associated with area deprivation (Leue et al., 2012).

The investigation will be supported by case studies located in Glasgow, Scotland.

This city was chosen as the main ground for the investigations of this research because:

1. The author lives in the city and research outcomes can be compared with direct experience of the built environment;
2. The author works for Glasgow City Council and could access fine grain

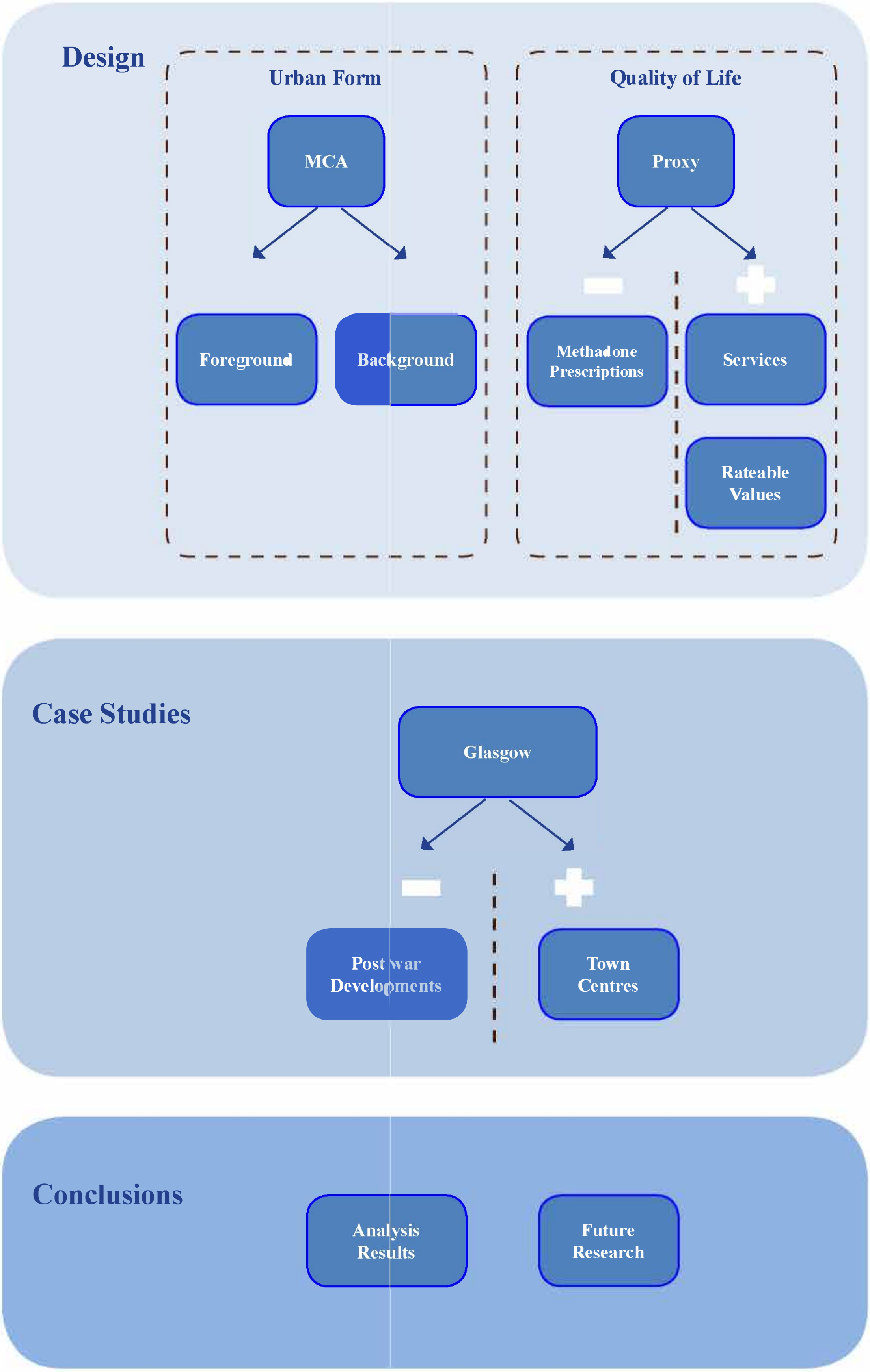


Figure 3. Research Design Flowchart

datasets essential to the development of this research;

3. The city of Glasgow is a medium sized urban centre in a wealthy First World nation, but it experiences some of the worst statistics in terms of deprivation in Europe; this makes it an interesting ground for research on the relationship between quality of Life and its determinants.

4. Glasgow is a complex city; while its city centre is a thriving area, lively by day and by night, where social outcomes are positive (SIMD), it presents peripheral post war developments where poor social outcomes have been persistent through time.

The case studies have been chosen according to their positive or negative social outcomes as indicated by the SIMD.

Results from the case studies analysis will seek to produce supporting evidence for the introduction of configurational analysis as supporting tools for urban designers, planners and decision makers.

The analysis of the results will also highlight opportunities for future research.

1.6. Organization of the thesis

The document is divided in 6 Chapters, an Appendix section and a reference, a figure and a table list.

Chapter 1 will introduce the research background and questions, outline the research design and define its limits. In particular it will introduce the concepts of Quality of Life and Urban Form which will be explored in detail in Chapter 2 and 3.

Chapter 2 will contain an analysis of the existing literature on multileveled life performance indicators, as well as the investigation of the discrepancies and similarities between different indexes and sets of indicators.

Chapter 3 will concentrate on the relationship between society and space and the development of configurational theories aimed at quantifying such relationship.

Chapter 4 will illustrate the method and the data sources for the case studies developed for this research.

Chapter 5 will contain the full analysis and results of the case studies.

Finally Chapter 6 will answer the research questions outlined in Chapter 1 and outline recommendations for further research.

The appendix will contain the maps illustrating the variation of the centrality indexes in particular areas of Glasgow's urban network which were developed for the case studies in Chapter 5.

1.7. Research limits

Multileveled concepts such as QoL, Deprivation, Segregation, etc. are very complex constructs branching into many different disciples and fields.

This thesis, even if comprehensive of a literature review on origins, definitions and methodologies applicable to the aforementioned concepts, will concentrate on the role played by urban form within this context.

The purpose of addressing social malaise through a configurational morphological approach is to reinforce the role of urban design through innovative solutions able to overcome the negative outcomes of deprivation (or low levels of QoL).

The approach adopted does not intend to undermine or criticise the existing approaches, just to add a new perspective to further reinforce them.

"It is important to emphasize that space has an explanatory power over the formation and persistency of deprived areas, (but) it is not replacing other explanations" (Vaughan et al., 2005).

The choice of Glasgow as a single ground for this research is not seen as a limit, as it enriches the existing literature on the Multiple Centrality Assessment which is currently mainly based on Mediterranean cities, with the study of a northern European urban centre that has been profoundly affected by modernist planning policies from the 1960s onwards.

2. Quality of Life: Multileveled Life Performance Indicators

2.1. Introduction

Chapter 2 presents the literature review on multileveled life performance indicators such as Quality of Life, well - being, deprivation, social exclusion, etc.

Figure 4. The many families of indicators contained in the Australian National Development Index (Source: http://www.andi.org.au/the-index)

In particular, the chapter will explore the differences between the indexes, which indicators constitute them, how are they chosen and why.

Current government policies in the UK and Scotland aimed at improving poor social outcomes will also be investigated.

2.2. Summary

Findings from the literature review indicate that often different life performance indexes are constituted by similar indicators. In particular we argue that indexes for Quality of Life and Deprivation are two faces of the same coin, the first presenting a positive outlook, how good is your Quality of Life, the second a negative one, how deprived is this area, this community, but both being calculated through similar sets of indicators.

Of particular interest, in this chapter, are the representative definitions of multileveled concepts like QoL, as well as the comparison between the most used indicators across the different indexes.

2.3. Monitoring Urbanisation Trends

The world's population has reached the staggering figure of 7 billion. And for the first time in history, of these 7 million, about 50% live in urban areas, and the figure is estimated to increase to 60% by 2030 (Buhaug et al., 2013) (UN-Habitat, 2013).

With the majority of the world's population living in urbanised areas, and the fastest rates of urbanisation happening in the developing world, it is now more than ever important to focus on the factors that drive the phenomena in order to enable a positive process.

Urbanisation can have both a positive and a negative connotation; historically it has been linked to economic development with the creation of urban centres with a strong work market and social livelihood (Davis, 1955); the same centres though have been known to ingenerate poverty, segregation, lack of basic services , inadequate housing and health inequalities (Marmot et al., 2012).

The rapid expansion of cities in the 21st century has created some unexpected challenges in the developed world; suburban, lower density areas, where paradoxically urban life is more expensive due to the lack of density itself and increased distance from services, have ingenerated social segregation, urban fragmentation, unrest, poor health (Chin, 2002).

According to the Un-Habitat report Time To Think Urban published in 2013 (UN-Habitat, 2013) a fundamental cultural shift in the way cities are planned is needed in order to ensure future sustainable developments and high levels of quality of life; revised planning policies will have to encourage mixed use cities and abandon mono functional areas, as well as promote the provision of functional urban spaces where social interaction can happen and stress the importance of addressing the city as a whole to avoid piece meal interventions; but most of all, the new policies, will have to be centred on the wellbeing of cities inhabitants, and in particular, the most vulnerable layers of the population (Prado-Lorenzo et al., 2012).

In 1997 the European Union published the Communication "Towards an Urban Agenda in the European Union" (COM(97)197) which stimulated a great deal of interest and discussion in all the EU institutions and local governments. The communication was not long after followed by a Framework for Action for Sustainable Development published in 1999 and then revised in 2004 (Policy, 2004). The framework set out to improve the integration of Community Policies for Urban Development and recognized the pivoting role of Europe's cities as centres for culture, social interaction and integration, economic engines and sustainable development. Whilst being acutely aware of fundamental differences between each city, in terms of culture, economy, climate, location, the framework acknowledged that cities across Europe have many factors in common which can be compared help them to learn from each other's experiences.

As a consequence the Urban Audit was launched in 2003 for the then 15 countries of the European Union, and was then extended to the new member states the year after, for a total of 321 Cities in 27 Countries, to measure and compare different aspects of Quality of Life.

The Lisbon strategy and EU's strategic guidelines for cohesion policy for 2007-13 stressed the importance of increasing the attractiveness of regions and cities and recognised that Quality of Life is crucial to provide an environment capable to attract and retain a labour force, businesses, students, tourists and most of all residents in an urban centre.

The drive to measure Quality of Life, rather than exclusively the gross domestic product (GDP) of a city or a country, derived from the recognition that economic factors on their own were not able to explain and convey the intricacy of contemporary living (Diener et al., 1997).

Research shows that many factors involved in the assessment of Quality of Life are related to wealth, but some like rates of suicide or Co2 emissions are not, confirming that economic prosperity is not the only driving factor behind a well-balanced and satisfied society (Diener et al., 1995).

2.4. Quality of Life

Research on Quality of Life (QoL) started in the 1970, in conjunction with the establishment of the Journal of Social Indicators Review, founded by Alex Michalos. Since then research on QoL has been addressed by many different disciplines like sociology, economics and political studies, while maintaining its main core in the domain of health. A key publication for QoL is the Journal of Happiness Studies; the International Society for Quality of Life Studies was also established as a forum to enable interdisciplinary research on QoL.

The basic idea of QoL stems from Maslow's hierarchy of human needs (Hagerty, 1999) (Hofstede, 1984) (Maslow, 1943) according to which individuals have to meet the most fundamental needs such as physiological, safety, friendship and family needs, before they start to focus on a second level of needs, such as morality, creativity, etc. to eventually achieve complete self-fulfillment. Following on this, QoL can be considered to describe how well all the above needs are met by one's life, and most importantly, to which extent they are perceived of being met in the strive to self-satisfaction.

The multifaceted nature of the concept of QoL has started many debates about its definition and measurement but no general consensus has been achieved even after many years of research on the field (Tuan Seik, 2000) (Bonaiuto et al., 2003) (Cummins, 1996) (Felce, 1997) (Pacione, 1980) (Petrucci et al., 2002).

The term in itself is very ambiguous as it is used in many different ways by different disciplines; Schalock reports the existence of over 100 definitions of it (Schalock, 1997). There is a general lack of agreement on what QoL is, what contributes to it, which are its outcomes and how it can be measured.

The lack of consensus is so evident that Farquhar (Farquhar, 1995) compiled a taxonomy of the definitions existing in literature in an attempt to create some order; the author defined four main families of possible definitions of QoL: 1- Global Definitions, 2- Component Definitions, which can be research specific or non-research specific, 3- Focused definitions, which can be explicit or implicit and 4- Combination definitions.

Global definitions are the most common in the existing literature, being the most general.

Component definitions break down the concept of QoL in its different factors, which can be research specific in order to target a particular aspect of QoL, or non research specific but still identifying a number of dimensions of QoL without necessarily cover the whole spectrum of possibilities.

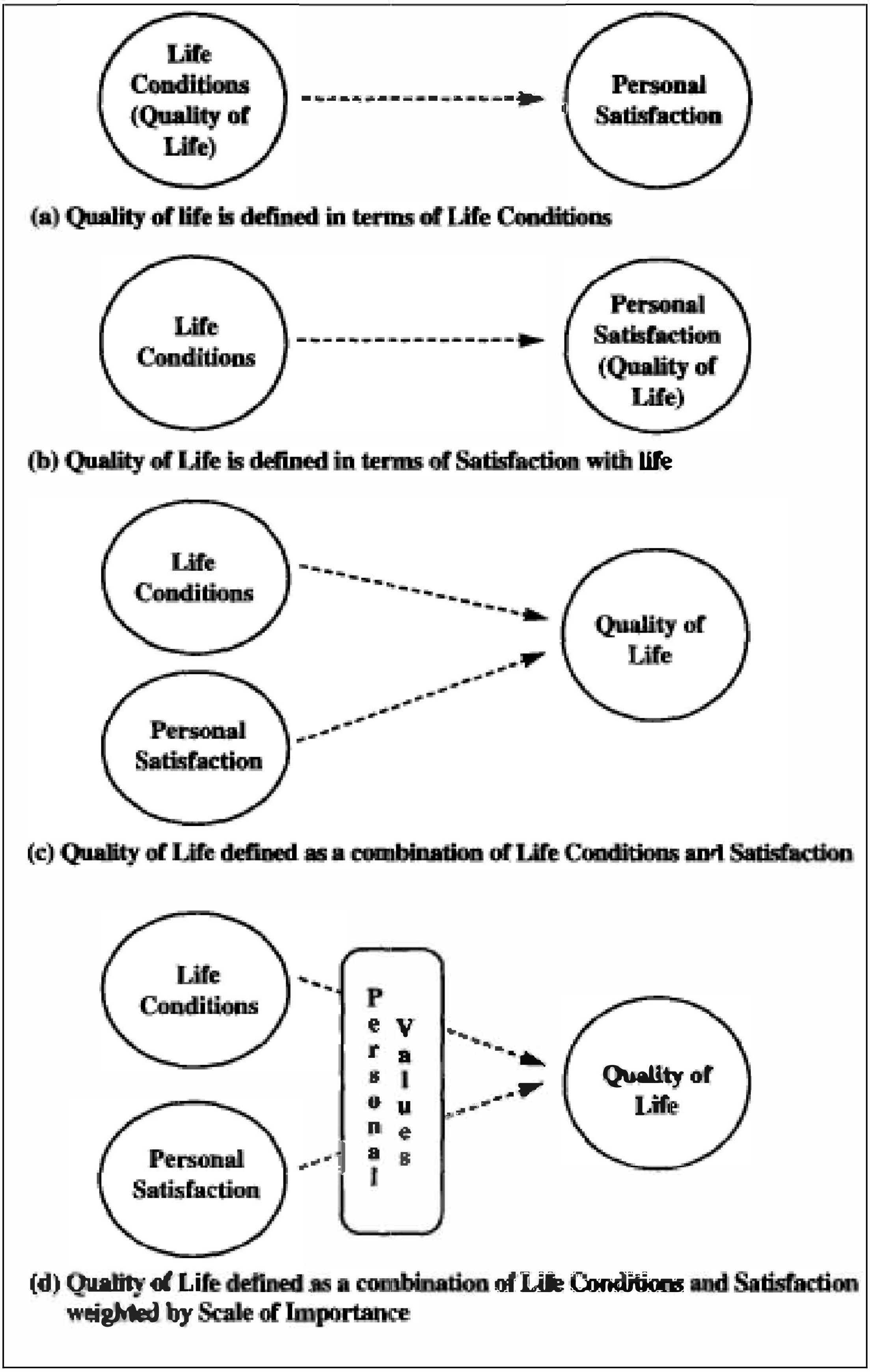
Focused definitions target just a few dimensions of QoL; they can be explicit, when the focusing only on a few indicators explicitly, or implicit, when the decision process is not openly introduced or discussed.

Combination definitions are Global definition of QoL with the addition of the specification of the dimensions addressed.

Taillefer et al (Taillefer et al., 2003) also conducted a systematic literature review of theory driven models of QoL addressing 68 models developed between 1965 to 2001 and identified three types of QoL models. A conceptual model, which describes the dimensions and properties of QoL; a Conceptual Framework, a model which not only describes the dimensions and properties of QoL but also explains and or predicts the relationships between the different elements of QoL; a theoretical Framework, which like the conceptual framework addresses the relationship between the different components of QoL but within a theory that support these relationships.

Felce and Perry (Felce, 1997) also carried out an extensive literature review on QoL and reported that the issue is generally addressed according to four main conceptual models (Figure 5):

- QoL defined in terms of Life Conditions
- QoL defined in terms of Satisfaction with life
- QoL defined in terms of Life Conditions and Satisfaction
- QoL as a combination of Life Conditions and Satisfactions weighted by a scale of importance .



(a) Quality of life is defined in terms of Life Conditions

(b) Quality of Life is defined in terms of Satisfaction with life

(c) Quality of Life defined as a combination of Life Conditions and Satisfaction

(d) Quality of Life defined as a combination of Life Conditions and Satisfaction weighted by Scale of Importance

Figure 5. Felce and Perry Conceptualization of Quality of Life. Source: (Felce and Perry, 1995)

The World Health Organization (WHO) while developing its own method to assess QoL in 1995 also attempted to identify which three main attributes are fundamental to the concept of QoL (Kuyken et al., 1995):

1. QoL is subjective- it depends on the individuals' perception
2. It is a multidimensional concept
3. It involves the individuals' perceptions of positive and negative dimensions.

This was challenged by Avant and Walker (Avant et al., 1994)who added that QoL needs both subjective and objective indicators in order to evaluate the circumstances of an individual's life. Meeberg (Meeberg, 1993) instead referred to QoL as a feeling of satisfaction with one lives' in general and argued that an individual would be able to self-assess its own QoL.

The attributes identified by the WHO, Avant and Haas and Meeberd represent the main areas of contentions in the attempt of defining QoL.

Notwithstanding the lack of consensus on one single definition, and the fact that terms such as life satisfaction, well-being, health status or living conditions are often used as synonyms of QoL, the necessity to assess the degree of QoL of an individual, community or a whole nation, is a firm point throughout the literature.

The overall assessment of human experience is approached through the construction of a QoL index, where different domains are addressed through a series of indicators relevant to the QoL model investigated (Health, urban living, etc.).

Raphael identified 11 main families of debate on QoL which need to be taken into account before approaching the construction of an evaluation methodology (Raphael et al., 1996).

The main debates, which are relevant to this literature, review concern:

1. The use of objective or subjective indicators
2. If QoL is a mono or multi levelled concept;
3. Which are the main domains of QoL;
4. Which is the role of values and cultural context.

The following section will explore the issues listed above in the current literature review.

2.4.1. Main debates on Quality of Life

2.4.1.1. Objective or subjective indicators

Indicators can be objective, based on data such as income, mortality rates, literacy rates, and any other data which can be gathered without a subjective evaluation of the individual or community being assessed; or subjective, based on data retrieved from surveys or one to one interviews.

The first efforts to construct an index of QoL were either completely based on economic indicators or objective socio indicators; in the 1970s research started the introduction of subjective indicators and Cummins reports how often an individual's assessment on its own QoL did not match the picture painted by hard objective indicators (Cummins, 2000).

Rapley identified the most commonly used objective and subjective social indicators adopted in QoL indexes throughout the literature, such as Life expectancy, Crime rate, Unemployment rate, or sense of community, Material possessions, or Happiness as reported in Table 1.

Table 1. Source (Rapley, 2003), p11

Frequently used objective social indicators (Represent social data independently of Individuals' evaluations)	**Frequently used subjective social indicators** (Individuals' appraisal and evaluation of social conditions)
Life expectancy	Sense of community
Crime rate	Material possessions
Unemployment rate	Sense of safety
Gross Domestic Product	Happiness
Poverty rate	Satisfaction with "life as a whole"
School attendance	Relationships with family
Working hours per week	Job satisfaction
Perinatal mortality rate	Sex life
Suicide rate	Perception of distributional justice
	Class identification
	Hobbies and club membership

Through the work of Cummins (Cummins, 1996), Felce, Perry and Pacione today the consensus is on the necessity of adopting both objective and subjective indicators in order to construct a meaningful index of QoL.

The Euromodule, for example, involves 19 research teams across Europe and uses national social surveys to compare data on QoL, welfare and wellbeing, where subjective and objective indicators have the same weight, as they are regarded of equal importance (Delhey et al., 2002).

2.4.1.2. Quality of Life: mono or multi-level?

Although mono level definitions of QoL are reported in literature, the general consensus is that that QoL is a multi-levelled concept (Felce, 1997).

Mono level definitions are used only in the case of health or life satisfactions in general, where QoL is assessed through a question like “how do you feel about your life as a whole?” as developed by Andrew and Whitley (Schwartz et al., 2003), rather than life satisfaction with specific domains of life considered individually (Rejeski et al., 2001).

2.4.1.3. Quality of Life: domains

The shared view reported in the literature is that the sum of the indications given by the domains or indicators constituting a QoL index will reflect the level of QoL as a whole. That is not to say that there is a shared view on which the domains should be.

The table reported below illustrates the approach taken by four different authors and by the World Health Organisation towards the definition of which domains are fundamental to the construction of a QoL index (Galloway et al., 2006).

The authors come from different disciplines like Health, Psychology and Disability and Social Indicators research; there is an overall agreement on some fundamental issues such as physical well-being, the individual’s role in society and emotional well-being, but then the issue becomes more controversial, for example some authors considers personal safety or work satisfaction as fundamental indicators, but others authors do not. Schalock and Verdugo reviewed 9749 abstracts and 2455 articles to produce a very useful summary of the most common indicators utilized in QoL indexes. They identified 8 core domains and for each domain the three most commonly used indicators (Galloway et al., 2006) (Schalock et al., 2002) as reported in Table 2.

The Core QOL domains comprise the most adopted domains in the existing literature, as summarised in Table 2, while the list of indicators in Table 3 confirms the general consensus in using both subjective (e.g.: contentment) and objective (e.g.: financial status, employment) indicators.

Table 2. Quality of Life, most adopted domains and indicators (Galloway et al., 2006) (Schalock et al., 2002)

Felce (1196)	**Shalock (2000), p188**	**World health Organization QOL definition (1993)**	**Hagerty et al (2001), pp 74-75**	**Cummings (1997)**
Disability, Psychology	Disability, Psychology	Health	Social Indicators Research	Disability
6 possible domains:	8 core domains:	6 domains:	7 core domains:	7 core domains:
Physical well being	Physical well being	Physical	Health	Health
Material well being	Material well being	Environment	Material well being	Material well being
Social well being	Social inclusion	Social relationships	Feeling part of one's local community	Community well being
Productive well being			Work and productive activity	Work and productive activity
Emotional well being	Emotional well being	Psychological	Emotional well being	Emotional well being
Rights or Civic well being	Rights			
	Interpersonal relations		Relationship with family and friends	Social/ family connections
	Personal development			
	Self determination	Level of independence		
		Spiritual		

			Personal safety	Safety

Table 3. Quality of Life Domains (Galloway et al., 2006)

Core QOL domains	**Indicators**	**Descriptions**
Emotional well being	Contentment	Satisfaction, moods, enjoyment
	Self-concept	Identity, self worth, self-esteem
	Lack of stress	Predictability, control
Interpersonal relations	Interactions	Social networks, social contacts
	Relationships	Family, friends, peers
	Supports	Emotional, physical, financial, feedback
Material Wellbeing	Financial status	Income, benefits
	Employment	Work status, work environment
	Housing	Type of residence, ownership
Personal development	Education	Achievements, status
	Personal competence	Cognitive, social, practical
	Performance	Success, achievement, productivity
Physical well being	Health	Functioning, symptoms, fitness, nutrition
	Activities of daily living	Self care skills, mobility
	Leisure	Recreation, hobbies
Self-determination	Autonomy, personal control	Independence
	Goals and personal values	Desires, expectations
	Choices	Opportunities, options, preferences
Social Inclusion	Community integration and participation	
	Community roles	Contributor, volunteer
	Social supports	Support network, services
Rights	Human	Respect, dignity, equality
	Legal	Citizenship, access, due process

2.4.1.4. Quality of Life: values and cultural context

Felce and Perry, amongst others, insist on the important role that personal values play in determining an individual's perception of QoL (Felce et al., 1996), (Schalock, 1997). In their QoL models they integrate subjective and objective indicators with personal values, which are defined as "the relative importance to an individual of objective life conditions and subjective well-being with regard to a given aspect of life "(Felce et al., 1996) and are adopted to weight the different aspects of a QoL index.

Shalock as well recognizes the importance of personal values and his QoL model changes according to the group of people being investigated, acknowledging that values can vary greatly between ethnic groups, age groups, etc.

Different societies and cultures have very diverse views on what is considered to be a good life; therefore every model of QoL has to be developed in its own context. Having said that Keith and Shalock investigated what they considered to be the fundamental factors of quality of life, both culture related and unrelated, in 7 different countries, and found that the core concept are generally shared amongst different cultures (Schalock, 2004). This is a very important outcome when we come to International QoL assessments, like the ones carried out by the World Health Organisation.

I would agree with Pacione that the role played by cultural values varies greatly according to the scale at which the study of QoL is being carried out. The smaller the scale of the study, city level, neighbourhood level, street level, or even at individual level, the greater is the role played by the cultural context and personal values (Pacione, 1986).

2.4.2. *QoL measurements*

QoL can be measured through a variety of approaches, which mainly depend on the field that QOL is measured in, whether it is within a health, sociology, or economic context. The context determines both the way QoL is defined and the indicators choice. Schalock summarised a methodological overview of how QoL is measured by devising three different systems levels as reported in Table 4.

Table 4. Methodological overview of QoL measurements (Schalock, 2004), p. 207

Systems level	**Measurement focus**	**Measurement strategies**
Microsystem	Subjective nature of QOL ("Personal appraisal")	Satisfaction survey Happiness measures
Mesosystem	Objective nature of QOL ("Functional assessment")	Rating scales (level of functioning) Participant observation Questionnaires (external events and circumstances) Engagement in everyday activities Self-determination and personal control Role status (education, employment, living)
Macrosystem	External conditions ("Social indicators")	Standard of living Employment rates Literacy rates Mortality rates Life expectancy

Schalock confirms in his findings that scale plays a very important role in the measurement of QoL and that indicators vary together with the scale; at a microsystem level objective indicators take precedence, while as we move towards a bigger evaluation sample, objectivity becomes more important.

The measurement of QoL of individuals often involves self-assessment through a questionnaire or an interview. Many very specific approaches on how to evaluate self-assessment have been developed, from one-dimensional single scale measurements to multidimensional single scale measurements, or multi separate scales (Haas, 1999).

The measurement of QoL of the population of a whole city or nation, instead, resides in the social indicators tradition, where the QoL index is constructed through the sum of a range of indicators, both subjective and objective, addressing relevant QoL dimensions ad domains. Often data is accessed through national surveys and national socio economic data, which enable researchers and policy makers to get the pulse of the situation without having to invest in the collection of new data.

Notwithstanding the scale of analysis, there are a number of problems, which are to be addressed when considering how to measure QoL.

1. Identification of domains and Justification of the rationale behind the choice of domains
2. Selection of indicators and Justification of the rationale behind the choice of indicators
3. Use of subjective or objective indicators, or a combination of both
4. Weighting assigned to QoL domains and indicators and justification of the rationale behind the decision taken

As discussed before authors agree on the importance of the role played by the cultural context, which can be expressed through the weighting assigned to the different indicators and domains. It is suggested that one could approach the construction of a QoL index by carrying out the survey twice: once to establish the importance given to the different domains by the sample being evaluated and extract the weighting, and only after this step, to carry put the survey with the relevant weighting in place (Bar-On et al., 2000).

2.4.3. Other definitions of Quality of Life

2.4.3.1. Well being

Pollard and Lee after a systematic review of the existing literature suggest that the term well-being suffers from the same problems as the concept of QoL, "a complex, multi-faceted construct that has continued to elude researchers' attempts to define and measure it" (Pollard et al., 2003).

From an economic point of view, well-being can be either a uni or multi-dimensional concept and can be measured as satisfaction with life in general, or satisfaction with different aspects or domains of life (Bell, 1985).

Across most disciplines the terms well-being is used interchangeably with QoL without a definition of its own. Christoph and Noll, in the field of social indicators research, adopt subjective well-being as a part of the idea of welfare which they consider to be a synonym us of QoL (Christoph et al., 2003).

Interestingly the New Zealand government refers to four different types of well-being:

1. Economic
2. Social
3. Environmental

And cultural; "the vitality that communities and individuals enjoy through: participation in recreation, creative and cultural activities; and the freedom to retain, interpret and express their arts, history, heritage and traditions" (Marriott et al., 2012) .

It is recognized that the four elements have to be addressed by local authorities in planning and practice in order to improve the levels of well being amongst their inhabitants.

2.4.3.2. Urban Quality of Life

Urban Quality of Life is the focus of this research as it embodies how well human needs are met by an individual or within a community in the context of different domains of urban living (Costanza et al., 2007).

The capability of humans to fulfill their basic needs in an urban context depends on the provision of social, built, human and natural capital (Costanza et al., 2007).

Governmental or local authorities policies underpin the provision of the four capitals necessary to shape a society able to provide the opportunities to fulfill humans' basic needs (Lee, 2008). The four species of capital can be defined as follows:

- Social Capital: " the features of social life – networks, norms and trust- that enable participants to act together more efficiently to pursue shared objectivise (Putnam, 1995)"
- Human Capital: the sum of capabilities, skills, social and personality attributes (such as creativity) necessary to the ability to perform labour and create economic value (Coleman, 1988).
- Built Capital: goods which have been manufactured, in the case of Urban Quality of Life, buildings, social spaces, streets, etc.
- Natural Capital: (Costanza et al., 1997) renewable and not renewable goods and services which have not been manufactured but provided by the ecosystem

For human beings to be able to achieve a satisfactory sense of well-being the above four capitals have to be provided, in different measures, which vary greatly according to the conditions surrounding each individual or community. Location, age group, economic status, ethnicity, are a few of the many factors to be considered in the provision of policies taking into account the provision of the four capitals.

Urban QoL (UQoL) is therefore a multi-layered catalogue, which emerges from the assessment of the levels of satisfaction of the multiple needs of an individual, a community or an entire society. Different needs would contribute at a different level to achieve satisfaction; therefore in the calculation of an index we would have to apply weights according to the relative importance of each factor taken into consideration.

From this QoL can be defined as the level of fulfillment reached by an individual or a community in respect to a series of indicators which are relevant to the natural, socio economic and built environment surrounding the subject or subjects being evaluated.

The evaluation of UQoL can vary greatly according to the temporal and spatial scale of analysis adopted, from the evaluation of individuals to the evaluation of a whole nation (Pacione, 2003). The choice of methods and indicators would be completely different; in the case of an individual we would consider a few objective indicators such as weight, age, exercise regime, income and employment status, but most likely we would rely on an interview and on a self-assessment of levels of satisfaction with one's life. But when we come to evaluate large samples of population relaying on subjective indicators becomes more complicated and often cost implications arise, so scale and measurement issues are a primary concern in the measurement of a QoL index.

According to Pacione the concern with Quality of life is a by-product of wealthy societies, where all primary needs have been met, and an index such as The Gross National Product (GNP) is no longer able to convey the overall status of wellbeing of a nation and its citizens (Pacione, 2003).

In particular the relationship between people and their everyday urban environment has been at the centre of much research on QoL; Michelson suggests that this specific relationship can be interpreted as to which level urban inhabitants feel comfortable or uncomfortable within their urban surroundings (Michelson, 1977).

Within social geography much effort has been dedicated to the evaluation of the quality of different living environments in large urban settlements where social conditions have highlighted episodes of very low QoL. Typical large urban settlements issues such as degradation, increased road traffic, outer migration, inequalities in health and services accessibility are central political issue in most EU countries and this is reflected in the effort sustained by research on urban planning and QoL.

As already mentioned concepts such as QoL, Urban QoL, Liveability, sustainability, urban environmental quality enjoy a moment of popularity in research programmes, governmental policies and urban development, but have not reached an integrated framework of assessment, ad are being used under a plethora of different definitions, by different disciplines.

Some representative definitions are reported in Definitions of different concepts addressing QoL in Table 5.

2.4.3.3. More representative definitions

Table 5. Definitions of different concepts addressing QoL

Livability / Liveability	
(Pacione, 1990)	Urban Liveability; liveability as an adjective does not refer to the environment itself but to the output of the interaction between individual and environmental characteristics. Pacione uses humane and liable as synonyms.
(Veenhoven, 1996)	Veenhoven refers to liveability as well as to habitability or overall QoL of a nation meaning the degree to which a nation is able to meet the necessities and the competences of its citizens
(Newman, 1999)	Newman sees cities as ecosystems and adopts an extended metabolisms model to assess their degree of sustainability (Newman, 1999). According to Newman sustainability is a function of three factors: environment, economics and livability. For the first time in literature health is one of the indicators necessary to assess liveability.
Environmental quality	
(Lansing et al., 1969)	"an environment of high quality conveys a sense of well-being and satisfaction to its population through characteristics that may be physical, social or symbolic"
(Porteous, 1971)	According to Porteus Environmental Quality is a multilevel concept, which involves subjective perceptions, scale of values, and cultural predeterminations, which vary between communities and individuals.
(de Hollander et al., 2003)	"Environmental Quality can be regarded as the "extent to which the environment fulfills the social needs of communities and individuals"
Quality of Life	
(Szalai, 1980)	An individual's well-being is determined both by objective factors in his life (wealth, health, etc.) and subjective factors, that is the perception that the individual has of the impact of the objective factors on his state of well-being.

(Groupt, 1993)	In 1993 the World Health Organization defined Quality of Life as: "An individual's perception of his/her position in life in the context of the culture and value systems which he/she lives, and in relation to his/her goals, expectations, standards, and concerns. It is a broad ranging concept, incorporating in a complex way the person's physical health, psychological state, level of independence, social relationships, personal beliefs, and relationship to salient features of the environment. This definition highlights the view that quality of life refers to a subjective evaluation, which induces both positive and negative dimensions, and which is embedded in a cultural, social, and environmental context."
(Veenhoven, 1996)	For Veenhoven the concept of Quality of Life equals to the idea of Happy life expectancy, the degree to which people live long and happily. The evaluation is achieved by a combination of objective data, such as life expectancy and subjective surveys on appreciation of life. The Happy Life Expectancy can be translated in the average numbers of years that a citizen in a certain country can be expected to live happily.
(Musschenga, 1997)	According to Musschenga a good life is based in three different factors: • Enjoyment: a healthy and positive state of mind • Satisfaction: to which point we are fulfilling our own life expectations and reaching our own idea of a good life • Excellence: the value that we attribute to our own activities
(Roloack, 1982)	Rosen (Rosen, 1979) and Roloack (Roloack, 1982) measure QoL of households through the monetary value of the amenities that are available in their vicinity. Amenities are location specific and can affect the index in a positive or negative manner.
Sustainability	
(Environment et al., 1987)	"Sustainable development is development that meets the needs of current generations without compromising the ability of future generations to meet their needs and aspirations"

(Dale et al., 2006) (Newman, 1999)	The United Nations in 1987 defined sustainability as "a global process of development that minimises environmental resources and reduces the impact on environmental sinks using processes that simultaneously improve economy and the quality of life"
(Camagni et al., 1998)	"Sustainability refers to a dynamic, balanced and adaptive evolutionary process, i.e. a process in which a balanced use and management of the natural environmental basis of economic development is ensured"
(Flores et al., 1998)	"Long term livability"

Although the review of different disciplines and definitions show many diverse approaches to the idea of UQoL, concepts like livability, Quality of Place, sustainability often overlap: they all refer to the relationship between individuals and the environment; they all seek to reveal the nature of the interaction between environmental conditions and human reactions.

2.4.4. Monitoring UQoL – Urban observatories

Table 6. Four archetypes of observatories (Farah, 2011)

	Explanatory Variables				**Potential implications on**		
	Objectives	**Participation**	**Professionalization**	**Sustainability**	**Improving urban action**	**Improving local authors cooperation**	**Local actors' empowerment**
City - University Partnership model	Learning oriented	Functional complementarity between city and university	No new professional or professional expertise	Weak: different agendas	Important: mainly in term of long-term perspectives	Superficial: two different cultures	Absent since the civil society is absent from this model
Public actor model (ex: the FNAU's urban observatories, France; number of urban observatories in Latin America and the Middle East)	Initially Monitoring Oriented	Weak, and aims mostly for validating, established choices	Important: development of a professional body with a technicist orientation	Important Institutional Sustainability: enshrined in a stable public sector environment	Important: mainly in terms of diagnostic production	Important: only between public actors	Absent since the civil society is only receptive in this model
Global network model (ex: UN-Habitat Global urban Observatory)	Monitoring and learning at the same time	Important	More important on a global level with a new network of professionals than on the local urban observatories level	Mitigated institutional sustainability but overall important social sustainability	Weak: since it is concentrating on MDG monitoring	Important: the observatory is built as a network	Important in the theoretical model though not always in practice
Local initiative model	Initially learning oriented	Variable	Variable	Important institutional and social sustainability	Variable with a tendency for artisanal tools that can be recuperated in urban actions	Variable with a tendency for informal cooperation	Important: based on actors appropriation of data and analyses

Urban management, that is the provision of services and policies which enable the functioning of the city, has to be supported by accurate information on economic, cultural, demographic, physical and environmental dynamics; said information, if monitored through the use of indicators over time, is also able to provide a valuable insight on the impact of the actions undertaken by local authorities (Ferreira et al., 2012).

As cities grow, the amount of data, which has to be evaluated by urban governances, is steadily increasing and so is the need of an effective management system able to monitor change and highlight meaningful fluctuations in data levels.

Jihad FARAH divides urban observatories in four main types: the City-University partnership model, the Public Actor Model, The Global Network Model, and the Local Initiative Model as illustrated in Table 6.

The City – University Partnership model emerged in the United States where in 1969 the launch of the National League of Urban Observatories Program prompted the creation of many observatories based on the collaboration between University Departments and local authorities.

The Detroit Area Study (DAS 2001) is one of the most famous and most successful examples within this typology of Urban observatories; the major program of research started in 1951 and was aimed at measuring quality of community life through subjective and objective indicators to inform planning and policy decisions in Detroit. The program explored issues like travel and transportation, neighbourhoods, parks and recreation behaviour, housing and residential mobility, sprawl and open space conservation (Marans, 2003).

We would claim that the Scottish Index of Multiple Deprivation (SIMD) also falls within this category, as it has been developed through the collaboration of, not a City, but the Scottish Government, and a university, in this case Oxford University.

The idea of monitoring deprivation, rather than QoL, opens up a debate on which we will further expand; at this point we can observe that the domains adopted in the construction of the SIMD are largely the same adopted in the structure of QoL indexes examined in this literature review (namely: Income Deprivation, Employment Deprivation, Health Deprivation and Disability, Education, Skills and Training Deprivation, and Geographical Access to Services).

The difference consists of considering those domains as reflective of a particular aspect of deprivation, rather than of lack of QoL. High levels of Income Deprivation, for example are conducive to high levels of Deprivation, rather than low levels of QoL.

The Public Actor Model is well represented within the FNAU (the network of the French urban planning public agencies) project, which collects data and analyses trends in urban centres across France. Farah argues that if that the programme had to be run solely by a Public Actor there could be a scarce level of public participation, and

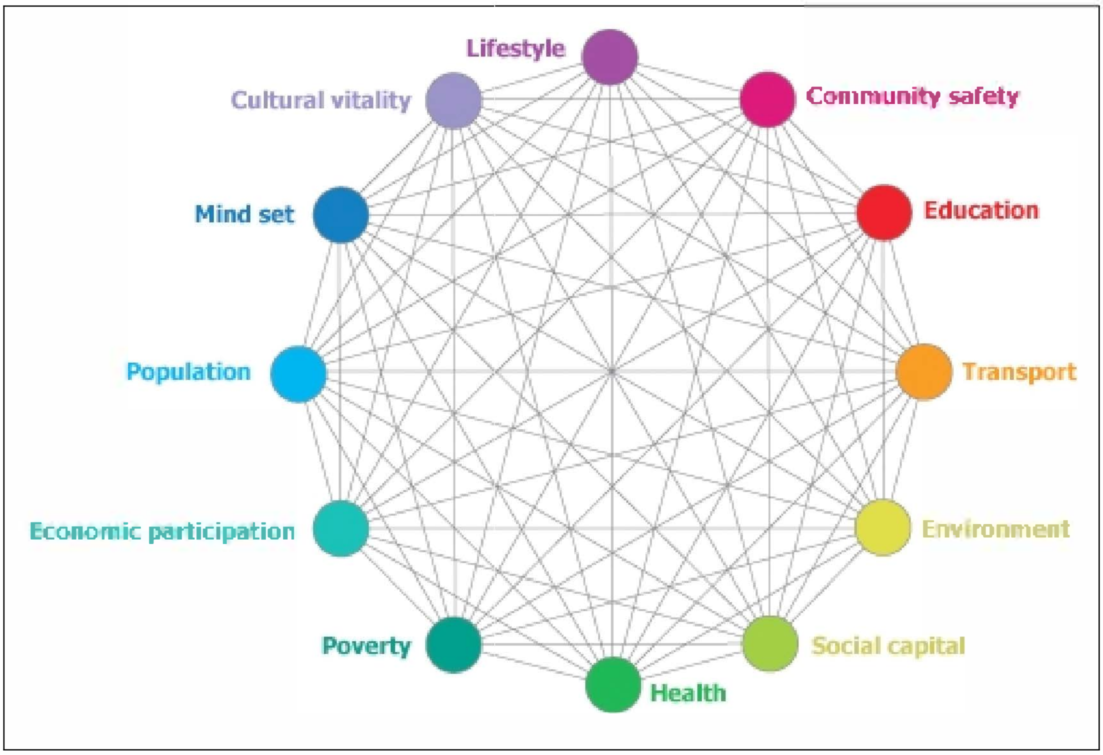


Figure 6. Groups of indicators on Understanding Glasgow: The Glasgow Indicators Project (source: http://www.understandingglasgow.com; date: 11/06/15)

the output would be only utilised by governmental agencies. On the plus side though, public funding as well as a consistent methodology and agenda ensures continuity in data collection.

The Global Network Model is the one promoted by UN-Habitat who in 1976 initiated an urban indicators collection programme through the United Nations Human Settlement Program, followed in 1991 by the Housing Indicator program and in 1993 by the Urban Indicators Program, which focused on the comparison of urban indicators from cities around the world. The Global Urban Observatory was then established in 1996 during the United Nations Conference on Human Settlements in Istanbul (Agenda, 1996).

The United Nations defined an Urban Observatory as a governmental agency, research centre or educational institution whose role is to develop monitoring tools able to inform policy and decision making; urban observatories have as a main goal to understand cities as economic and social systems and as a consequence to promote effective and targeted planning (Habitat, 2003) through the implementation of both the Agenda 21 and Habitat Agenda.

Agenda 21 was developed in 1992 as a detailed action plan adopted by 171 countries worldwide aimed at promoting sustainable development based on principles of environmental safeguard, economic efficiency and social integrity. The action plan also details strategies for urban development based on the principles of sustainability and which are to be based on the data collected by Urban Observatories (Sitarz, 1993), (Selman, 1998).

The Habitat Agenda was formulated in 1996 to assess the progress achieved by Agenda 21 and set fresh targets for the new millennium. The overall sustainability aim of Agenda 21 is reflected in the Habitat Agenda with a particular focus on targeting urban poverty and achieving “Cities Without Slums” (Known as Target 11) by 2020; the agenda defines a set of urban indicators and stresses the importance of assessing the evolution of urban settlements through constant monitoring of data fluctuations.

According to the Un-Habitat program, Urban Observatories can be established at Local, Regional or National level, and have to feed back to the Global Urban Observatory whose role is to monitor worldwide change and to support the formation of new Urban Observatories mostly in developing countries.

Many Urban Observatories have been established through the Un Habitat program, such as the Regional Base Observatory of Sustainability Indicators (RBOSI) launched in 2004 in Parana, Belo Horizonte and Recife in Brazil, as well as Vancouver in Canada, Jeddah in Saudi Arabia and Merida in Mexico.

Going back to Farah’s taxonomy, the Local Initiative model is the most flexible option within the ones examined as it can be tailored to suit the needs of each particular local authority.

The Glasgow Centre for Population Health, for example, is a Glasgow City Council initiative, where a group of professionals with different backgrounds focus on improving health and tackle inequality in the city; the group initiated the project Understanding Glasgow: The Glasgow Indicators Project, a web based platform opened to the public, where a set of 12 groups of Glasgow indicators (Figure 6) can be explored, mapped and compared.

Understanding Glasgow does not offer a single index, but separate indicators able to convey a deeper understanding of what was happening in the city rather than a unified result; the website allows for more independence in the consultation of the indexes, which can also be compared between one another.

The website is very well used by the public and in constant evolution, capable of adapted to best reflect changes in the city.

Glasgow City Council has also embarked in a very ambitious £24million program called Future City-Glasgow, a partnership between public and private sector as well as academia, which involves addressing issues like health, safety and sustainability through open data, apps, portals and citizen science mapping.

The program is being developed at the moment but it already has a web portal, Open Glasgow, where data can be visualized and downloaded. Interestingly for future research mobile telephone applications are being developed to crowd source data on walkability and cycle routes, in an effort to target specific problem areas across the city and increase both on feet and cycle traffic into the City Centre.

Crowd sourcing is a different method to collect data which has not been addressed in any of the precedent literature review but is a promising approach to model people's responses towards space (Klettner et al., 2013).

The creation of an application able to give an indication of how walkable a street or a neighbourhood is, still involves the development of an index through the determination of which indicators to adopt much like in the case of QoL indexes; in this particular instance though, such indicators would have to be easily and quickly scorable by anyone walking in the area with a telephone in their hands. The index would also have to rely on an algorithm able to weight the indicators according to their hierarchy within the index and produce a final score for the street or neighbourhood.

People continuously evaluate their surroundings (Fahrenberg et al., 2007) and a number of studies in the field of environmental psychology indicate that environmental characteristics can affect well being (Ulrich, 1986), (Kaplan et al., 1989), (Hartig et al., 2006) satisfaction (Hur et al., 2010) and behaviour in space. Changes in behaviour in space can affect social interaction (Sullivan et al., 2004), the perception of how walkable an area or a street is (Leslie et al., 2007), as well as navigational choices (Zacharias, 2001).

Such crowd sourcing mobile applications therefore rely on the assessment of the built environment that is carried out instinctively by human beings but on top of that have to be able to get citizens to use them consistently in order to be able to collect a representative data sample.

In the case of the walkability index application, the challenge consists of being able to make citizens aware of how they can help shape the future of their own city through a minimum effort and create a sense of responsibility towards building the data.

Data on cycling instead will be easier to collect, as urban cyclists tend to have focus groups, which are already fighting the battles that the application wishes to inform and have demonstrated of being extremely proactive in data sharing.

Data will not be available to be analysed before the end of my PhD but future research could focus on the assessment of the interaction between crowdsourced walkability indexes and urban morphology indicators across the city.

With a different approach again, Esri, the company behind ArgGis, one of the most adopted Geographic Information systems by local authorities worldwide, started a project which does not quite fit in any of the categories determined by Farah.

Esri, powers a website called Urban Observatory which enables the comparison of data from the Great Cities of the 21st Century and stresses the importance of a worldwide systematic method of data collection and visualization (ESRI,).

The Urban Observatory website consists of two different sections; the Immersive Exhibit, with dynamic data, authoritative maps derived from many different sources, will be unveiled at the summer of 2014 Esri International User conference in San Diego (CA), while the website itself is already available for exploration by the general public at the moment enables the investigation and comparison of data from 5 different world cities.

These last two initiatives demonstrates how effective the combination of data, geography and maps can be in the understating of human behaviour in the built environment and in the guidance of effective decision making towards the building of a human scale responsive environment.

2.4.5. Geographical Distribution of Urban Quality of Life

The tremendous work carried out by Urban Observatories in the monitoring of UQOL highlights how not only it is important to understand "what happens", but it is also fundamental to know "where it happens".

Spatial patterning of population and land use in the city, spatial distribution of problematic behaviours and social life within neighbourhoods and what these all mean for levels of QoL in a city life are very relevant subjects of the urban discourse (Van Kempen, 1994).

According to Marco Brambilla not only it is important to know what happens where, but also to make sure that the resources available in a city are equally distributed across the territory if we want to really make a difference to the overall QoL of an urban centre; the paper Equity in the City: On Measuring Urban (Ine)quality of Life (Brambilla et al., 2013) frames a new way of assessing QoL which takes into account the concept of equity and geographical distribution of resources.

According to Brambilla, notwithstanding the choice of methodology adopted to assess QoL or wellbeing, it is commonly agreed that the opposite of equity – inequality is disadvantageous for QoL and in particular that the concentration of disadvantage or deprivation in areas of the city can generate negative externalities such as social discontent, crime, social and economic marginalization (Galster et al., 2010). Further to this, Brambilla and his team developed a calculation able to assess the uneven availability of resources within a city, which, according to the authors, conveys an indication of levels of QoL. The index is tested on the city of Milan and results show that increasing the level of activities in given areas can improve QoL locally, but that the even distribution of facilities is able to affect positively levels of QoL across a whole urban area. In practical terms it is a more efficient solution to spread even resources across a whole city in order to better its levels of QoL, rather than addressing one neighbourhood at the time in isolation from the wider context.

Brambilla proves the existence of a very strong link between QoL and equality, or indeed to its opposite, inequality; it is therefore fair to claim that we can just as meaningfully measure QoL following the methodologies developed to date and reviewed earlier in this section, or we can assess the lack of QoL, opening a whole new discussion on how to measure the pulse of a nation, a city, a neighbourhood, by exploring low levels of QoL together with their geographical distribution.

2.5. Social Inequalities

2.5.1. Inequality, Poverty, Deprivation, Segregation

The terminology QoL contains a positive connotation possibly evoked by the word "quality", when in fact the same categories of indicators included in QoL indexes can be adopted to investigate concepts like inequality, deprivation, exclusion all of which carry a more negative connotation.

The definitions of Inequality, Poverty, Exclusion, (Urban) Segregation and Deprivation collected from the existing literature in Table 7 refelect how such concepts, just like QoL, are multi-dimensional constructions, which can be assessed through the development of ad hoc multi-levelled indexes.

Table 7. Inequality, Poverty, Deprivation definitions

Inequality	
CEELBAS	Social inequality refers to the ways in which socially-defined categories of persons (according to characteristics such as gender, age, 'class' and ethnicity) are differentially positioned with regard to access to a variety of social 'goods', such as the labour market and other sources of income, the education and healthcare systems, and forms of political representation and participation. (CEELBAS,)
(Szaflarski, 2005)	Income Inequality: Income disparities
(Kawachi et al., 2002)	Health inequality is the generic term used to designate differences, variations, and disparities in the health achievements of individuals and groups.

WHO	Health inequality and inequity: Health inequalities can be defined as differences in health status or in the distribution of health determinants between different population groups. For example, differences in mobility between elderly people and younger populations or differences in mortality rates between people from different social classes. It is important to distinguish between inequality in health and inequity. Some health inequalities are attributable to biological variations or free choice and others are attributable to the external environment and conditions mainly outside the control of the individuals concerned. In the first case it may be impossible or ethically or ideologically unacceptable to change the health determinants and so the health inequalities are unavoidable. In the second, the uneven distribution may be unnecessary and avoidable as well as unjust and unfair, so that the resulting health inequalities also lead to inequity in health.
Poverty	
(Wade, 2001)	The United Nations distinguish two forms of poverty: • Human poverty is “ defined by impoverishment on multiple dimensions – deprivations in a long and healthy life, in knowledge, in a decent standard of living, in participation” • Income poverty “is defined by deprivation in a single dimension- income”
(Hagenaars et al., 1985)	In order to identify people living in poverty the idea of a poverty line is introduced, an income level considered to be the borderline between the poor and the not poor.
(Watts, 1968)	Economic definition of poverty: poverty is considered a situation where income, representing command over resources, falls below a certain level.
(Hagenaars et al., 1988)	All definitions of poverty will fall within one of the following 3 categories: • Poverty is having less than an objectively defined, absolute minimum (absolute poverty, basic needs approach) • Poverty is having less than others in society (Relative poverty, in respect to income or different commodities) • Poverty is feeling you do not have enough to get along (Absolute and Relative Poverty: subjective evaluation of the level of income necessary to run the household)

(Van Kempen, 1994)	Modern Poverty: low income alone is not sufficient to define the poverty problem in post industrial welfare states, but social isolation and permanent dependency on the state should also be considered.
Deprivation	
(Wade, 2001)	The United Nations report that Deprivation can be explained and assessed, both at individual or community level, as the lack of satisfactory levels of "dietary, clothing, housing, home facilities, environment, and work (paid and unpaid) conditions" and Social Deprivation, as the lack of access to the rights in relation to" employment, family activities, integration into community, formal participation in social institutions, recreation and education".
(Townsend et al., 1988)	According to Townsend deprivation is relative to societal norms, which vary across time and place; it is a multi-dimensional concept – encompassing basic necessities (diet, clothing, etc) and the wider context (educational activities, working conditions, etc). It can be both material and social, but it is more than just a question of income; it is a phenomenon that that affects people rather than areas.
(Sen, 1976)	According to Sen people are deprived when they are restricted in their freedom to make choices about what they want to be and do; the broadest possible range of constraints on wellbeing should be considered– e.g. discrimination, disability, a hazardous living environment, etc.
(Jenkins, 1994)	Wage differentials due to discrimination
(Pacione, 1989)	According to Pacione: "Multiple deprivation is characterized by the spatial coincidence of social, economic and environmental disadvantages"

Exclusion	
(Wade, 2001)	Social exclusion focuses not only on the impact but also on the process of marginalization; individuals or groups can be become excluded from participating to social or community life for example by: a) legal exclusion, (b) economic exclusion; (c) exclusion due to lack of provision of social services (e.g. unavailability of translation services or disabled facilities); (d) exclusion due to stigmatisation (e.g. people with HIV) or de facto discrimination.
(Peace, 2001)	Social exclusion can be defined and used in two ways: • As a synonym for income poverty referring to those people who are not included in the paid labour market or those who are in low-wage work. • As a synonym of income inequality, deprivation or lack of employment.
UK Social Exclusion Unit 1999	Social exclusion is a shorthand label for what can happen when individuals or areas suffer from a combination of linked problems such as unemployment, poor skills, low incomes, poor housing, high crime environments, bad health and family breakdown.
(Berghman, 1995)	Social exclusion is not as a state or outcome but a dynamic process
(Giddens, 2013)	``Exclusion is not about graduations of inequality, but about mechanisms that act to detach groups of people from the social mainstream"
(Burchardt et al., 1999)	"An individual is socially excluded if (a) he or she is geographically resident in a society but (b) for reasons beyond his or her control he or she cannot participate in the normal activities of citizens in that society and (c) he or she would like to so participate."
Segregation	
(Robert et al., 1925)	The study of "natural areas, i.e. areas of population of population segregation" is one of the first things that an urban sociologist wants to know about the city.

(Olsson Hort, 1994)	According to Olsson Hort segregation is a spatial phenomena. It can manifest in different scenarios, such as the labour market or the neighbourhood where differences can occur between different social groups. Segregation defines boundaries between social groups as well as hierarchies of power between them, influencing collaboration and interaction.
(Westin et al., 1995)	Segregation is defined as a separation from the whole and can exists in many different areas of social life, such as the labour market, the neighbourhood, in school, health care and especially within the housing market. Westin stresses that segregation is related to a spatial differentiation and that housing is a key element of it.
(Acevedo-Garcia et al., 2003)	“Residential segregation refers to segregation in regard to the composition and spatial distribution of the population of an entire metropolitan area across its neighborhoods; thus, residential segregation is a multilevel concept that combines information on 2 geographic scales. It is also a multidimensional construct consisting of 5 distinct geographic patterns: dissimilarity, isolation, clustering, centralization, and concentration. Because racial residential segregation usually refers to the separation of Blacks from Whites, we refer to the dimensions in terms of Black–White segregation. However, the dimensions apply equally to other racial/ethnic groups and subgroups as well as to income segregation (e.g., segregation of poor from non poor individuals)”
(Park, 1926)	Immigrant settlement can be divided in three stages: life in a inner city ghetto, upward mobility and finally dispersion (integration).
Residential or Housing Segregation	
(Massey et al., 1988)	“a multidimensional phenomenon varying along five distinct axes of measurement: evenness, exposure, concentration, centralization, and clustering;”
(Bolt et al., 2010)	Residential segregation is measured through quantitative methods according to how people, or social groups, are distributed geographically, that is according to where people reside. The categorization of social groups is mostly based on economic, ethnic or demographic data, as well as tenure (private or social housing) or hosing type.

It is interesting to note that the vast majority of the literature that we have retrieved about Segregation refers to Residential segregation and most often than not has been developed in the US and discusses ethnic residential segregation. When we explored European based literature on Residential segregation the issue moves towards the formation of residential areas where people experience urban poverty and the ethnic factor is no longer the main driver of segregation.

The health sector was again at the forefront of research in this field followed closely by social studies; many indexes were purely based on heath data (Carstairs, 1995) or on economic considerations and census outputs (Messer et al., 2006) (Gordon, 1995), while more complex constructs linked socio economic deprivation to poor health outputs (Cubbin et al., 2000) or mortality (Cadum et al., 1998).

Most importantly the indexes measuring lack of QoL and QoL contain the same families of indicators and variables, which can vary according to circumstances, data availability, and scale of research.

In 1991 the paper "Which deprivation? A comparison of selected deprivation indexes" (Morris et al., 1991) carried out an examination of five different indexes of deprivation, namely:

1. SCOTDEP, developed by the authors to analyse Scottish Health data;
2. TOWN, developed by Townsend et al to analyse the Northern region;
3. JAR – developed by Jarman and associates to respond to the need of primary

care services;

4. DOE – Department of Environment measure to aid urban policies;

5. SDD- Scottish Development Department measure to aid urban policies.

As we can see in Table 8 the range of variables is not dissimilar to the one identified in Table 2 for QoL indexes, although we have to bear in mind that those particular five deprivation indexes were formulated using exclusively census sourced data which is unable to identify many different aspects of life style and life situations.

Segregation in particular addresses the idea of separation and it is a spatial concept, as social distance manifests itself in physical separation. Often the concept of segregation is associated with residential segregation, indicating a lack of social relations between different social groups defined by socio economic, ethnic, or demographic characteristics, which can occur within a neighbourhood. As a result neighbourhoods in cities can be labeled as segregated, deprived or excluded; such labeling can result in an unfavorable perception and stigmatization of the area, which is often very difficult to shift.

Table 8. Range of variables in any of the five indexes (Morris and Carstairs, 1991)

Large households Journal Of Publich Health Medicine					
	ScotDept	**Jar**	**Town**	**Doe**	**Sdd**
Unemployment	✔	✔	✔	✔	✔
Youth unemployment					✔
No Car	✔		✔		
Low social class	✔				
Unskilled		✔			✔
Overcrowding	✔	✔	✔	✔	
Below Occupancy Norm					✔
Not owner- occupied			✔		
Lacking Amenities				✔	✔
Single Parent		✔		✔	✔
Under age 5		✔			
Elderly households					✔
Lone Pensioners		✔		✔	
1-year immigrants		✔			
Ethnic minorities		✔		✔	
Vacant dwelling				✔	
Permanent sickness				✔	
Level And Access (Old)				✔	
Level and access (,5)				✔	
Permanent Sickness				✔	
Large Households				✔	

In the UK deprived areas are often concentrated in modern post war and 1970s suburbs; in Glasgow areas like Castlemilk[1], the Red Road Flats (now partly demolished), Drumchapel or Sighthill (also in the process of being demolished) present high levels of deprivation.

Such labels might over simplify the description of such areas, which often present similar spatial properties and characteristics, but segregation, and housing segregation in particular, has to be addressed to ensure the social and economic growth of such areas.

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1 *I'm a skyscraper wean; I live on the nineteenth flair,*
But I'm no' gaun oot tae play ony mair,
'Cause since we moved tae Castlemilk, I'm wastin' away
'Cause I'm getting' wan meal less every day:

Oh ye cannae fling pieces oot a twenty story flat,
Seven hundred hungry weans will testify to that.
If it's butter, cheese or jeely, if the breid is plain or pan,
The odds against it reaching earth are ninety-nine tae wan.

On the first day ma maw flung oot a daud o' Hovis broon;
It came skytin' oot the windae and went up insteid o' doon.
Noo every twenty-seven hours it comes back intae sight

'Cause ma piece went intae orbit and became a satellite.
On the second day ma maw flung me a piece oot wance again.
It went and hut the pilot in a fast low-flying plane.
He scraped it aff his goggles, shouting through the intercom,
"The Clydeside Reds huv goat me wi' a breid-an-jeely bomb."

On the third day ma maw thought she would try another throw.
The Salvation Army band was staunin' doon below.
"Onward Christian Soldiers" was the piece they should've played
But the oompahman was playing a piece an' marmalade.

We've wrote away to Oxfam to try an' get some aid,
An a' the weans in Castlemilk have formed a 'piece-brigade'.
We're gonnae march to George's Square demanding civil rights
Like nae mair hooses ower piece-flinging height.

Adam McNaughton, 1967

2.5.2. Deprivation: UK and Scotland

Social segregation, deprivation and conspicuous life conditions inequalities affect many areas within the United Kingdom's conurbations.

In particular, a substantial proportion of the disadvantaged live in urban areas in Scotland, which have been severely affected by the global economic restructuring, the deindustrialization of the UK economy, and ineffective urban policies (Pacione, 1989).

National policies to address poverty and deprivation in the UK were first promoted in the 1960s when specific reports on issues like housing, social services, and education increased the government concern on the well fare of the population.

The Urban Audit Programme constituted the main anti poverty policy in the UK from 1965 to 1977 with the primary objective to invest in deprived communities.

In 1977 the White Paper on the Inner Cities stressed that the main causes of urban problems were economic and suggested the creation of a programme of financial assistance managed by central government in collaboration with local authorities.

The following conservative governments (1979 to 1987) continued the policies first developed by the labour administration but argued the necessity of an increased collaboration between the public and private sector.

As a result the Enterprise Zones were born; EZ had as a primary goal the creation of new employment through a series of benefits such as exemption from rates, and fast tracking of bureaucracy such as simplified planning procedures, etc.

To the same effect Scotland founded the Scottish Development Agency in 1975 which has lately received some criticisms for not having at heart the real economic, social and environmental revitalization of depressed areas, but instead of focusing too much on attracting private investment to capitalize and exploit the natural advantages of Scottish economy (Pacione, 1989).

In 1998 a new Labour administration created The Social Exclusion Unit and extended the scope of concern beyond poverty) under a strictly economic point of view) by including the notion of social exclusion and recommending that polices should shift from a passive to active welfare intervention.

This resulted in a series of programmes which streamed additional public resources at local areas experiencing high levels of deprivation; such funds supported initiatives developed by local agencies and local communities, in recognition of the pivoting role of social relations and local agencies in the development of neighbourhoods (Alcock, 2004).

Since 1997 cities have been at the very core of the New Labour Government's agenda; Lord Rogers' Urban Task Force report "Towards An Urban Renaissance" (Force, 1999), examined the proposal of building 4 million new homes in 25 years without using any of the green belt or unbuilt areas of countryside, and recommended that urban regeneration should be design led, able to improve social well being, focused on social responsibility and supported by a viable economic and legislative framework. For the first time, the quality of the built environment is considered to be crucial in the fight against deprivation.

In addition to this, in order to gain a more precise insight in the extent of deprivation in the UK, four indexes of deprivation were developed for its four constituent countries, based on research carried out by the Social Disadvantage Research Centre the University of Oxford (Noble et al., 2006). The four indexes measure Deprivation through a dedicated Index Of Multiple Deprivation tailored to the needs and cultural

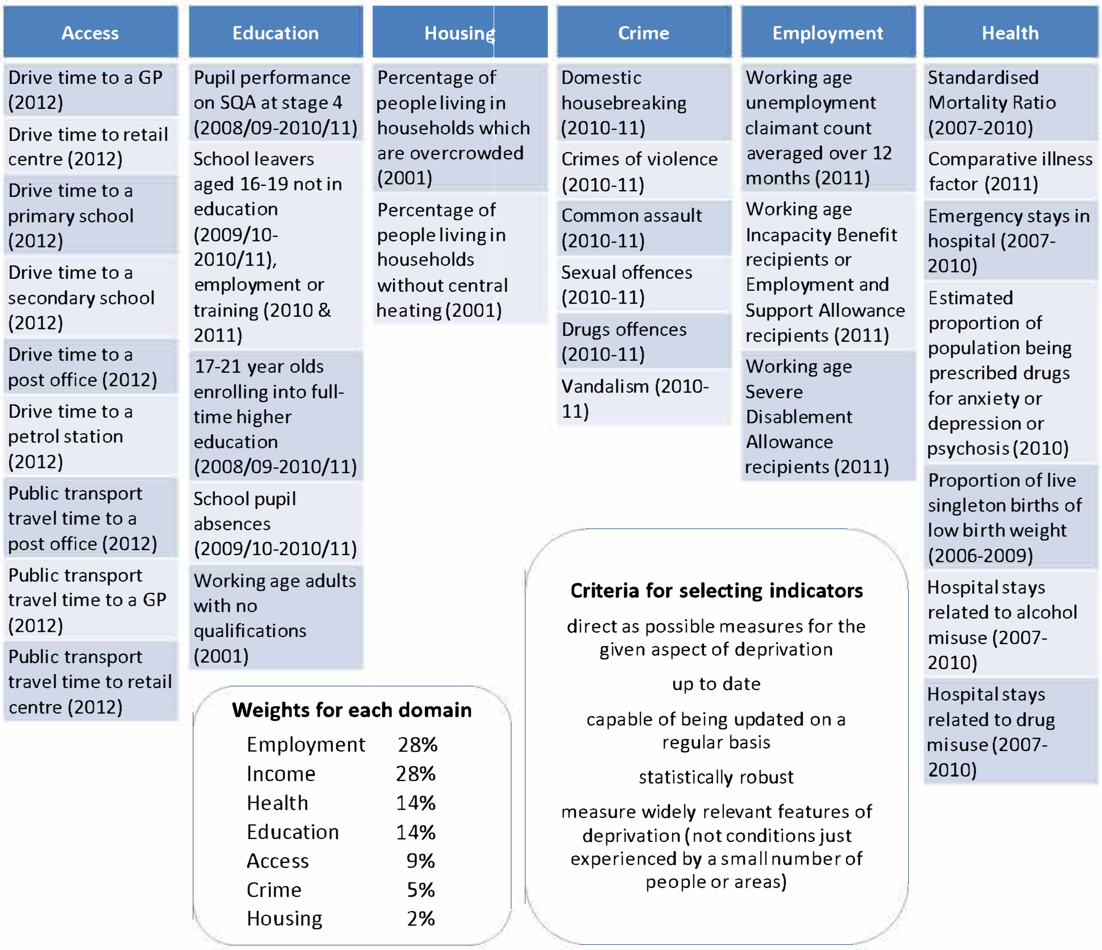


Figure 7. Indicators in the SIMD 2012 domains. The families of indicators are not dissimilar to the ones adopted in QoL indexes. (Source: http://www.scotland.gov.uk/Topics/Statistics/SIMD; date: 20/04/2014)

backgrounds of each particular country.

The four indexes are not directly comparable, due to the adoption of different indicators and the application of different weighting, however the two domains of income and unemployment are common to the four indexes and offer an opportunity for monitoring at UK level (Payne et al., 2012).

The Scottish Index of Multiple Deprivation encompasses seven different domains (Income, Access, Education, Housing, Crime, Employment and Health) each of which is assessed through a wide spectrum of indicators (Figure 7).

Most importantly, as already mentioned, the SIMD is a working tool for anyone who is involved in policy making or urban studies as it is able to rank the most deprived to least deprived datazones across Scotland.

The SIMD website hosts an interactive mapping tool (Scottish Government, 2011) able to display the results for each of the seven domains as well as the overall index results; it is also possible to carry out a longitudinal study, as results from 2004, 2006, 2009 and 2012 can be displayed on the map. Geographies can also vary enabling analysis at different scales (Intermediate Geographies, 2011 Scottish Parliamentary Constituencies, Local Authorities, Health Boards, Multi- Member wards).

The mapping ability of this tool is one of its strongest assets as it is able to immediately convey how deprivation varies across the different available geographies and highlighting critical patterns, which can then be analysed further and targeted through ad hoc policies.

The smallest geography offered by the SIMD is the datazone, a key small-area statistical geography defined by the Scottish Neighbourhood Statistics which covers the whole of Scotland (Scottish Government, 2005), which is able to provide a good overview of neighbourhoods but not small enough to allow a street by street analysis.

The Scottish Government, in its further commitment of addressing deprivation, in 2013 published two very important policy documents, Designing Places and Designing Streets, framing a complete new approach to regeneration focused on high quality design and place making.

Good Places, Better Health has also been recently published to reinforce the link between the built environment and health outcomes.

2.5.3. Deprivation: a priority on the Scottish Government Agenda

Scotland presents many urban areas where a diversity of complex, interconnected factors such as economic decay, unemployment, low levels of educational achievements, and poor health levels have merged to generate concentrate multiple deprivation and an harsh environment for people to live in.

Notwithstanding the past thirty years of policies trying to target such disparities, inequalities between different geographical communities are persistent and have proven very difficult to be addressed, as supported by the results of the SIMD.

Scottish Government believes that it is necessary to increase local autonomy and flexibility to address high levels of deprivation in Scotland's communities, whilst optimizing the use of existing budgets and resources to combine economic development and physical regeneration (Government, 2009).

The strategic policy context is framed by the data outlined by the SIMD results in 2009:

The built environment is an important element of the government's agenda which aims to create Successful Places by: "…striving for socio-economic change for people living in our most deprived communities, and being committed to a achieving sustainable physical change at the same time. At the local level, community planning partners should seek to maximise the combined impact of all activities aimed at improving deprived communities and aim to contribute to the achievement of relevant outcomes

Table 9. Equal Communities In A Fairer Scotland: A Joint Statement; the SIMD 2009 results clearly demonstrate the priority areas in need of being addressed by ant deprivation policies, such as health, education, employment. People who live in the most vulnerable areas where unemployment rates are very high are often excluded from society on many other levels such as access to facilities, health, education and culture (Lewis et al., 1999).	
National Outcome	**SIMD 2009 Evidence**
We realize our full economic potential with more and better employment opportunities for our people.	26% of people living in the 15% most deprived areas are employment deprived compared with 9% in the rest of Scotland.
Our young people are successful learners, confident individuals, effective contributors and responsible citizens.	A quarter of school leavers in the 15% most deprived area enter negative destinations, not involving employment, education or training. The rest of Scotland sees 12% of its school leavers going onto negative destinations.
Our children have the best start in life and are ready to succeed.	In the 15% most deprived areas, 20% of mothers of babies born in 2008 were breastfeeding at 6-8 weeks. For the rest of Scotland at the same time 40% of mothers were breastfeeding.
We live longer, healthier lives.	In the 15% most deprived areas, males are expected to live to 69 years. Females are expected to live to 76. For the rest of Scotland, the corresponding figures are 76 and 81 respectively.
We have tackled the significant inequalities sin Scottish society.	32% of people in the 15% most deprived areas in Scotland are living in poverty, compared to 15% in the rest of the country.
We have improved the life chances for children, young people and families at risk.	In the 15% most deprived areas, 42% of children are living in poverty, compared to 16% in the rest of the country.
We have strong, resilient and supportive communities where people take responsibility for their own actions and how they affect others.	24% of people in 15% most deprived areas, rate their neighbourhood as fairly or very poor compared to 4% in the rest of the country.

prioritised in Single Outcome Agreements (SOAs)"(Government, 2009).

Scottish Government is committed to achieve equal living conditions across different communities; however the difference between the most and the least attractive housing areas is still striking.

In Scotland, which manages a much greater stock of public housing than any of the other constituent countries in the UK, the public sector contains a higher proportion of marginalized households who are unemployed, sick or disabled, who are lone parents and who have a more disadvantageous ratio of housing costs to income than owner-occupiers. Certain parts of urban Scotland present an high concentration of local authority housing "which reveal polarized and marginalized communities" (Taylor et al., 2000).

Even if according to Richard Sennett cities offer the opportunity of being aware of others and of society through the experiences in public space, which is highly influenced by how the built environment has been designed (Sennett, 1992), Scottish housing estates often present a landscape which is not able to offer this kind of experience: functions are often separated, such as business, shopping or residential making interaction in public spaces more difficult to occur.

The possibility of creating places, neighbourhoods, residential areas, with public areas where people can mix is of uttermost importance in the fight against segregation and deprivation; the priority of this thesis is unveiling the role played by space configuration in relation to the strata of socio economic variables able to measure quality of life.

3. Urban Form: formation and study of the city fabric

3.1. Introduction

Chapter 3 will investigate the link between socio-political backgrounds and the built environment through the influential urban ideas that shaped our cities.

The relationship between the physical and the social city will be explored to unveil if and how urban form is able to influence social outcomes as well as the distribution in space of social inequalities.

This chapter also explain the reasons behind the adoption of the Multiple Centrality Assessment as one of the main tools in this research, through a comprehensive literature review and comparison with a similar tool, Space Syntax.

3.2. Summary

Cities have often been shaped by design dogmas based on social theories and strong economic drives; the tension between the two has often resulted with the creation of places not conducive to thriving civic lives like in the case of remote garden cities, or segregated post war peripheral estates.

The established link between urban behaviour and space has been explored through different methodologies, through observation like in the case of Gehl's Public Space

Public Life Analysis (Gehl, 2011), or though a set of theories able to relate urban form and human behaviour quantitatively like in the case of Space Syntax (Hillier, 1996). A third approach, the one chosen for this research, is represented by the Multiple Centrality Assessment ,able to produce urban form indicators which can be mapped in GIS and overlayed with further socio-economic data on the urban environment. The ability of overlaying different sets of information with urban morphology indicators enable the study of their relationship.

3.3. The Urban Expansion

3.3.1. How has the city been shaped by its politics?

Social and political backgrounds are strongly related to urban design ideas, and never like during the 20th century changing social ideas have been reflected in the built environment (Hanson, 2000).

In the UK, the Victorians had to cope with a conspicuous and fast city growth in the middle third of the nineteenth century; Glasgow grew at 3.2% per annum in the 1830s, Manchester and Salford at 3.9% in the 1820, Bradford at 5.9%, and London was as always ahead of the game (Williamson, 2002).

During the industrial revolution there was uncontrolled migration from rural areas to the expanding industrialized centres; the creation of such levels of housing congestion rapidly deteriorated into slums conditions, with frequent outbreaks of dysentery, typhoid, cholera, pneumonia, meningitis and tuberculosis; nutrition was often poor. Around the 1860s the development of public health in Britain promoted widespread sanitation and clean water supply to all households, but it was not until the latter part of the nineteenth century that the slum clearance started with a series of experiments to provide better housing conditions for the still growing urban populations (Godfrey et al., 2005).

Official slum clearance began through local Improvement Acts obtained in Liverpool (1864), Glasgow (1866), and Edinburgh (1867) which were a reflection of the social and political thought of the period and were very time and place specific (Yelling, 2012).

The story of working class housing provision shows a steady progression from laisser-fare to municipal initiative; landlords and rate payers objected to bearing the costs of the required interventions, while more modern thinkers insisted on the necessity for a heavier involvement of the public sector.

The public sector was not able to take the matter of land use and housing provision really until World War 1 and the private sector dominated the scene.

The construction of local authority housing only started properly after World War I; 2 million houses were built before 1939, over 4 million more after the war. To begin with, council housing was envisioned for the "working classes", but, after 1919, it started addressing the provision of housing for general needs.

Towards the 1930s Council Houses began to provide a dwelling for people displaced after slum clearances; council estates were built in locations where they would not affect the values of owner-occupied property, with the creation of ghettos and the stigma related to living in them.

In 1948 the Town and Country Act was published to finally define the role of the public and private sector in matters of land use, and the 1960s and 1970s saw the construction of a large stock of public housing supported by the Labour administrations in power.

The conservative government withdrawn the support to housing policies in the 1980s, substituted the construction of new housing stocks with Housing Benefits and implemented the sale of Council Houses to tenants (1981: right to buy – Margaret Thatcher), as well as the implementation of the transfer of existing housing stocks to Registered Social Landlords (in Glasgow: from GHA to Local Housing Associations).

The years 2000 saw a good start for the private sector, which was badly interrupted by the credit crunch in 2008. In 2009 the government brought forward social housing plans to stimulate economic growth in the country, which are still being implemented.

Slum clearances and housing policies had a great influence in shaping the urban landscape in the UK: cities stopped their concentrical organic growth while in order to relocate big portions of population required land use planning and political legitimacy.

This is the background that facilitated the birth of urban sprawl well before the advent of the Architectural movement of Modernism with mono-functional areas as well as the separation of social classes in different areas of the city (middle class garden suburbs were built in the mid 1800s – Great Western Road in Glasgow is a perfect example).

The creation of mixed community was also a concern from the very beginning; it can be traced back as far as the 19th century idea of the Garden City, through the publication of the Town and Country Act and is still high on the UK government's agenda at the moment.

The rapid urbanisation of the industrial revolution era caused a great increase of residential and social segregation which has not been resolved; many of the deprived - segregated areas existing in the mid 1800s are still problematic today (Vaughan, 2007). Wilson (Power et al., 2000) in examining social exclusion identified the harmful effect of living in deprived neighbourhoods. His research forms the base of the "Sustainable Communities: People, Places and Prosperity" Report by the Office of the Deputy Prime Minister (Great Britain. Office of the Deputy Prime, 2005), which sets out the Government's five year plan to create sustainable inclusive communities across England:

"People living in deprived neighbourhoods are less likely to work, more likely to be poor and have lower life expectancy, more likely to live in poorer housing in unattractive local environments with high levels of antisocial behaviour and lawlessness and more likely to receive poorer education and health services. Living in a deprived area adversely affects individuals' life chances over and above what would be predicted by their personal circumstances and characteristics."(Great Britain. Office of the Deputy Prime, 2005).

Unfortunately the creation of mixed neighbourhoods has not to date been able to resolve the issue of areas where poverty and deprivation have been resilient; the social aspiration behind the concept has led to interventions aimed solely at the built environment which has been an enormous improvement in the context of public health. But poverty, deprivation and segregation have not been resolved (Wilson, 2012).

We argue that the configuration of space and the effect that this has on public life has been overseen as a major factor in the poverty – neighbourhood equation.

3.3.2. *Influential Urban Ideals*

Many of the slums clearances of the mid 19th century in the UK were inspired by Haussmanns' diagonal boulevards; local authorities released new portions of land which were mostly developed through speculative rigid grids without any real concern with topography (Klose, 2005).

In a context of overcrowded cities, ruthless developers interested only in increasing their personal wealth, municipalities with very limited powers, Ebenezer Howard developed a new living model, The Garden City, as an alternative to the status quo.

Howard claimed that social justice should be for all, and his model of city planned for 30.000 inhabitants should be able to deliver just that.

In Garden Cities of Tomorrow published in 1902 Howard described how such Garden Cities should be located in a circle around each major cities, should be self supporting to be able to decentralize big urban centres (Batchelor, 1969).

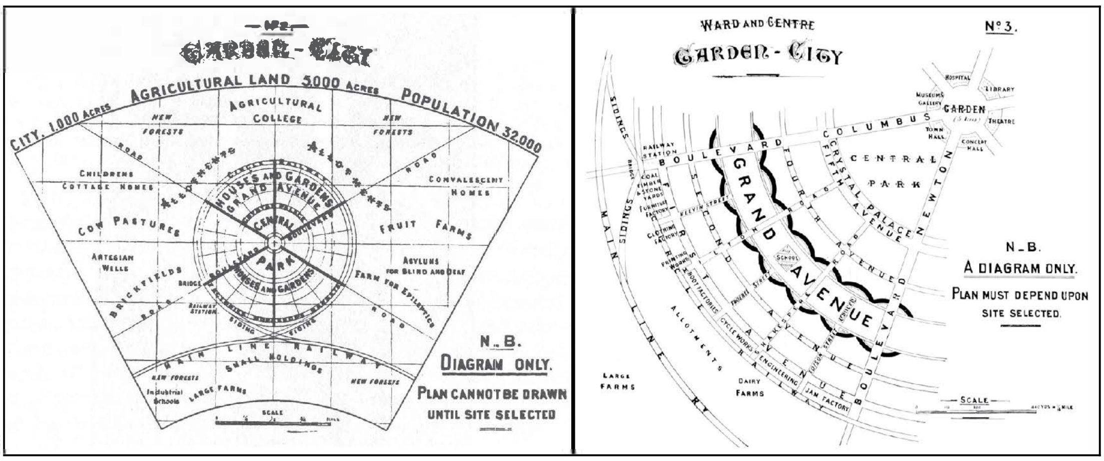


Figure 8. The principle of the Garden City of Ebenezer Howard (Howard, 1965)

Unfortunately Howards' vision never quite succeeded in its application as Garden Cities were built across the world but never quite managed to become independent and functioned more or less like commuting suburbs of their nearby bigger urban centres. The idea of building spatially separate city parts, with separate functions (e.g. one area for work, one for living, one for shopping etc.), was enduringly established and would have a great inspiration on new urban theories to come.

Notwithstanding the urban design ideas developed by Camillo Sitte, who valued the importance of the quality of urban space over the architecture of buildings, the critique toward the compact city increased.

Dense urban blocks with very little open or public spaces, parks, or recreation facilities still often characterized the inner city areas, while the new urban thinkers wanted sun, light and clean air.

Modernisms, with its freestanding buildings and powerful aesthetics, inspired by the work of Le Corbusier and Walter Gropius, took over the world of architecture and urban design with its alleged rationality and cost effectiveness.

Traditional cities were seen as old fashioned; new forms of transportation together with the new rationalist architecture encouraged the development of housing estates outside existing cities.

The suburb became a symbol for the future, the chance for a new and more equal society.

3.3.3. The neighbourhood unit

According to Silver, neighbourhood planning started with the first American settlements; by the mid 1880 the idea of neighbourhood was being promulgated by the social workers in urban settlement houses, who were able to appreciate the important role played by neighbourhoods for social cohesion (Silver, 1985).

In the early 1900s neighbourhood planning remedies were essentially anti-urban as it was common belief that the dispersal of urban workers into industrial villages would have restored the long lost community sense.

Towards the 1920s Clarence Perry formulated his “Five Block Plan”, a self-contained neighbourhood unit, usually centred on a school or a community centre, with facilities such as local shops and services, where pedestrian and vehicular traffic were separated. Perry believed that his idea of neighbourhood would have provided several benefits: lower housing density; an increase of open space available to all residents; protection from vehicular traffic; and the creation of a cohesive community (Perry, 1939).

Modernist urban planning, rooted in positivism and with a blind refusal of the past, aimed to create a better society through the creation of improved conditions for the urban poor (Hobson, 1999).

New modernist towns were dominated by the car, with a different pedestrian grid, and the urban block was no longer based on the 400m rule but was often doubled, if not

Figure 9. The Principle of Perry's Neighbourhood Unit(Perry, 2013) The Garden City together with Perry's neighbourhood have been extremely influential ideas; even if diluted together they formed the basis for town planning in the UK, and inspired many post 1945 new towns programmes on both sides of the Atlantic.

tripled, making pedestrian movement a very unattractive choice (Mehaffy et al., 2010). Although planning theories have evolved and changed greatly from the 1960s, the basic concept of the neighbourhood unit as an area built primarily for housing and specifically for households with children is still dominant. A series of baseline services have to be found in a neighbourhood such as schools, medical facilities, some local retail, green areas and recreational areas.

Even recent developments in UK cities, unlike Perry's neighbourhood unit that was supposed to be highly integrated in the urban fabric, are cut off from neighbouring areas by high speed roads, undefined greenery, railways, physical barriers that make car traffic and absolute necessity even if the general desire is to encourage pedestrian movement (Figure 10, Figure 11).

Figure 10. The new masterplan for Sighthill in Glasgow; the site is cut off from neighbouring areas by high speed thoroughfares, does not interface with the adjacent Canal area, does not offer mixed use and greenery is mainly used to fill in resulting spaces rather than being an active design component. (Source: www.urbanrealm.com)

Figure 11. Oatlands, Glasgow, development started in 2001. Although the layout presents an effort towards the creation of an urban block, the neighbourhood is still segregated from its surroundings by high traffic roads and mixed used is far from being achieved. (Source: www.glasgow.gov.uk)

3.3.4. New Urban Layouts

Inadequate housing was a major concern for policy in the UK until at least the 1960s and the discourse shifted on the social conditions related to housing really only after the 1970s (Cullingworth, 2002), and is still high on UK governments agendas today.

As we learned in the previous section, since the slum clearance of the industrial cities the relocation of big portions of urban populations has been addressed through the creation of new neighbourhoods, which evolved from a combination of Perry's' and Howards' ideas.

Between the late 1800s and the early 1900s the construction of new neighbourhoods

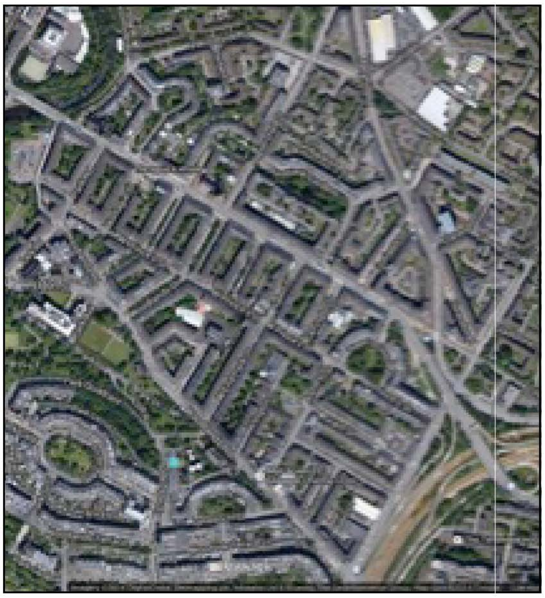


Figure 12. Woodlands Road, Glasgow; the streets layout follows the dense perimeter block model; Woodlands road is the primary street, it has a larger section than the secondary street surrounding it and buildings have commercial activities at the ground floors.(Image ●2015 Google)

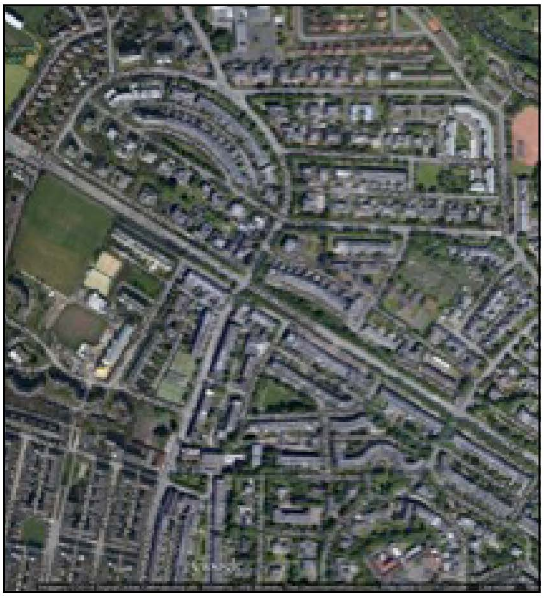


Figure 13. Great Western Road, Glasgow; the main thoroughfare presents a much wider section than Woodlands Road and entrances are well separated from the street. In the areas behind GWR the layout is typical of a Garden City, scattered with very expensive stone mansions. (Image ●2015 Google)

was dominated by two innovations, the high density perimeter block with 4 to 5 stories based on the examples established in Paris, Vienna and Berlin as reflected in Woodlands in Glasgow (Figure 12), and the middle class villa suburb fully represented by the area around Glasgow's Great Western Road (Figure 13).

Howard's principles for Garden Cities ruled over urban design between 1905 and 1930 with the provision of terraced houses and mixed garden suburban blocks, through a combination of detached and semidetached houses and small family blocks (in Glasgow, Pollock is a fine example, Figure 14).

In the 1930s the 3 storey lamella blocks revolutionized the traditional urban block;

entrances to residences were no longer located towards public streets or public spaces, shops and services were concentrated in the planned neighbourhood centre instead of being spread along blocks as it was in the traditional city, and pedestrian and vehicular traffic were separated as much as possible.

As the lamella layout inspired by CIAM evolved in the 40s and 50s the separation between functions accentuated; streets became dedicated exclusively to transportation (mono functional) and were no longer a place where people could go about their

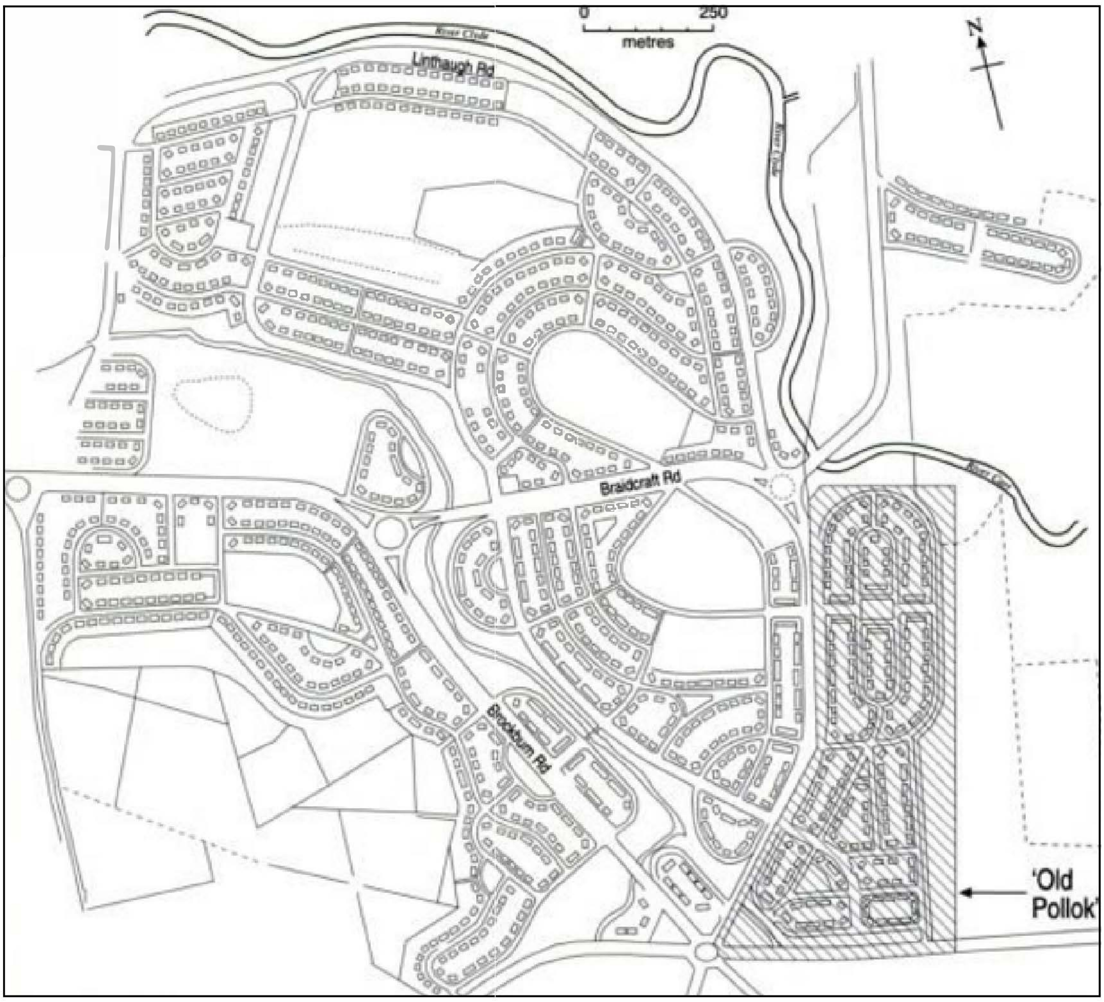


Figure 14. Layout scheme designed in 1935 for Pollok was completely in keeping with the garden movement providing a variety of cottage style houses separated by walled gardens. Source: (Fyfe, 2006)

everyday activities and meet (multi functional). As a consequence, residential buildings lost their relationship to the street and tower blocks whose layout bore no relation to street layouts, became more and more popular with the creation of a series of undefined and underused public spaces surrounding them (Gehl et al., 2006).

This was also reflected in the later development of Pollok in Glasgow; the council stated that it was no longer affordable to construct low-density housing estates, and so the new high-density era began.

Figure 15. Linthaugh Road, Pollok, Glasgow: one of the many post war higher density developments in the city. In the 1920s and 30s most council developments had been houses, but by 1935 the emphasis was on flats (Miller, 1970). Outer estates were to be connected to the city centre through high-speed roads. Source: urbanglasgow.co.uk

By the 1960s new suburbs (in Glasgow: Easterhouse, Drumchapel, Pollok, Castlemilk) were built as segregated enclaves, where vehicle and pedestrian traffic were completely parted, entrances had been removed from the streets, and buildings were often separated by parking lots. Open spaces lacked character and were really a way to fill the open space between buildings, instead of having a social function.

After the mid seventies, the 'post modern period' delivered more tower blocks and more mono functional suburban developments; although from the 1980s the construction of tower blocks has ceased, we are still designing mono-functional neighbourhoods and our cities have a large legacy of tower blocks which has only been marginally addressed though mainly maintenance based programmes.

To create physical environments able to support social communities the influence of the built environment on human behaviour has to be fully acknowledged once and for all.

While planners, urban designers, policy makers and sociologist have explored the reasons behind the failure of several housing estates across the UK concentrating only either on the built environment or on socio economic aspects, this thesis stresses the importance of considering how the social and the physical city work together.

3.4. Society and Space

The relationship between urban form and social life, and the concrete urban design solutions that would stem from it, are still largely unattended in planning policies. Sociological studies investigating the relationship between every day life activities and the built environment do not approach the problem in a systematic way.

According to Hillier though the lack of a theory-like proposition linking the social and the physical aspects of the built environment is a major fault. In fact, he argues, this gap is often filled with believes that do not have any scientific support and are often inadequate and the source of costly mistakes (Hillier, 2008).

This section will explore how the built environment has been explored in relation to social life through a series of seminal studies.

3.4.1. The traditional city

George Simmell in The Metropolis and Mental Life depicted quite a bleak portrait of life in Berlin at the beginning of the 1900s; according to his analysis city life has become corrupted through over psychic stimulation and commodity temptations. As a result urban citizens, as they are busy performing the rituals of their modern lives, are develop an individualistic attitude that stops them from developing significant social relationships (Simmel, 1903). Simmell expresses a real concern on the effects of space on social interaction and although his views are somehow pessimistic, may be due to the overall cultural climate they were developed in.

The Chicago School in the 1920s was hugely influenced by Simmells' work but concentrated more on the economic drivers of city form, such as the distribution of land uses, populations and urban problems such as concentration of crime or road accidents, instead of on the social aspects of the built environment (Hillier, 2008).

A few years later Luis Wirth argued that urbanisation brought deep changes in practically every aspect of social life, and with the spreading of the urban way of life well beyond the physical boundaries of cities, human relationships are generally becoming segmented, anonymous, superficial and transitory. The influence of a dense and heterogeneous built environment on society is not seen as positive at all, Wirth believes that the lack of sentimental ties between urban citizens ingenerates a spirit of competition and mutual exploitation rather than a sense of community (Wirth, 1938).

Simmel and Wirth developed their somehow gloom theories on how cities can influence the behaviour of their inhabitants in Berlin and Chicago one at the beginning of the last century and the other about twenty years later. Both cities presented a traditional grid structure, with urban blocks with mixed activities at the ground floor, all the principles that are in a new urbanism handbook, but nevertheless produced a negative outcome according to the urban sociologists of the time.

The reaction came into the form of a refusal of dense urban environment and an idealization of less dense rural settings (Howards' and Perry's garden suburbia).

3.4.2. Suburbia and Housing Schemes

The reaction to the traditional cities and the modernist movement brought a new social logic to cities and Jane Jacob drew a vivid criticism of this transformation in the 1960s with The Death and life of Great American Cities (Jacobs, 1961).

Jacobs compares cities built with traditional block structures with modern suburbs and housing estates; according to her critique modern urban design principles result in the construction of areas that lack livelihood and diversity.

Jacobs recognizes that the form of the built environment plays an important role in the creation of a thriving and interesting urban life. The lack of contact with neighbours impoverishes private lives, especially for woman and children who spend longer time in their residences ingenerating what she describes as the explosion of the private sphere. On top of that Jacobs argues that such low densities are not conducive to an efficient use of resources in terms of energy, infrastructures, and travelling times to work places. Habermas supported Jacobs critique of modernist urban design by arguing that the urban form in traditional cities was able to support activities from the public and private sphere in the same location; newly designed housing schemes and suburbia instead provided an environment where the private sphere was harder to be developed and the public sphere was at times completely lost (e.g.: non working women, people who are retired or out of work being segregated from public life) (Habermas et al., 1974).

In traditional urban blocks access is secured to both public space – the street, and private space – the interior or the back garden; such arrangement was deemed as old fashioned when traffic oriented planning became a priority but modernist urban layouts were not able to provide the same level of interaction between public and private space, causing a loss of the features that characterized city life, as the private sphere grows much bigger than the public one (Habermas et al., 1974).

Both Jacobs and Habermas recognize that the lack of public life in modern suburbia and housing estates is a consequence of urban form that is not able to provide the right levels of accessibility to public spaces for locals or non-locals.

The suburban dream of lower dense environments, with small inward looking courtyards, windy roads and cul-de-sacs, promotes the utopia of strong communities with low crime rates; according to both Hillier and Jane Jacobs though, density, when well managed, is an asset that fosters the right conditions for urban life, avoids the creation of fragmentary, unintelligible and underused spaces which tend to encourage anti social behaviour.

Julienne Hanson through the study of London's morphological changes has concluded that different design theories are connected to specific preconditions for sociability (Hanson, 2000). Housing estates designed on the basis of social theories aimed at the creation of strong communities expressed through modernistic urban layouts have failed their goal by isolating people from each other, both on the neighbour and on the neighbourhoods level, rather than facilitating social relations.

But what are the specific characteristics in built form that allow for a thriving civic life? As cities are recognized to be places for sociability questions are raised again on the specific relationship between urban form and social outcomes.

3.5. Social theories and cities

According to Friedland and Boden "place persists as a constituent element of social life and historical change" and it is of fundamental importance to civic life ((Friedland et al., 1994); in particular this thesis will focus on how a particular aspect of the built environment, urban form, can help shape social outcomes.

Hillier insists on the necessity of developing studies that focus on the understating on the existing built environment rather than the production of rules based on dogmas supposed to guarantee architectural success; social theories and design theories have to be interlinked and be based on the observation of the influence of the built environment on living and working patterns (Hillier, 1996).

Hillier and Vaughan (Vaughan, 2007) argue that spatial form has to be integrated as a contributing factor in forming the patterns of low QoL or deprivation in urban environments.

However morphological and social studies of the city do not seem to be able to combine effectively the two layers and as a result many partial theories about the city have been developed but not one able to see the city as a whole (Hillier et al., 2007).

Spatial configuration plays a very important role in the determination of whether a settlement can offer a successful public- civic life or not. According to Hillier in fact spatial configuration is able to influence how a collection of buildings can become a place or not and the shape of the street network in itself is a key determinant of movement flows and co-presence in space (Hillier et al., 1993). Hillier synthetized his approach into the Space Syntax theory that we will discuss in detail later in this thesis, together with the concept of centrality in networks which we will adopt for our case studies.

During the twentieth century many urban environments designed with urban sociology theories in mind have failed to succeed as a place and Hillier suggests that the role played by the configuration of space has often been denied and never quite explained leaving a lack of direction for urban designers and policy makers.

Jan Gehl also recognized the lack of a clear theory able to explain the relationship between architecture and behaviour and addressed the problem through a completely different point of view. Gehl investigated how different sections of the population use public space in different built environments. According to him activities in public space can be necessary, optional or social, and the physical environment heavily influences such activities. Activities can be carried out at different level of intensity, from low (seeing, hearing, etc.) to high (establishing relationships, etc.), and each level of activity plays an important role in the development of public life (Gehl, 1980).

Gehl emphasises how important it is to gain information on public life in space and that the only way to unveil the influence that the built environment has on behaviour is through direct observation; furthermore he believes that the space framed by buildings is far more important than the architecture itself in the evaluation of public life.

For the purpose of this thesis his observations on street design are extremely relevant as that is the scale of the case studies developed in Glasgow.

In particular Gehl highlights how walking is of uttermost importance for city life and therefore public space has to be able to facilitate and encourage one of the most basic activities of city life. We will be examining how the concept of centrality plays an important role in the identification of which streets are more likely to be walked through in an urban street network and how the configuration of the street network itself is able to influence such dynamics in the chapter addressing the methodology developed for this thesis.

3.5.1. Modernist Urban Layouts and Isolation

Laura Vaughan conducted an in depth analysis of urban segregation utilizing the Space Syntax theory developed by Hillier (Vaughan et al., 2005), (Hillier et al., 2007), (Vaughan, 2007); her findings confirm that space plays a fundamental role in the creation of resilient poverty areas in urban settlements; the most vulnerable strata of the population are particularly affected by spatial segmentation as they depend more on local movement and local networks for support and exchange (Vaughan, 2007)

Hanson believes that modernist urban layouts disrupt urban life by making the pattern of peoples' everyday life actions impossible to be reproduced in the new overdesigned environments. The way people used space, meet one another, behaved with one another was changed by the new configuration of space, and not for the best (Hanson, 2000). Hanson also investigates the shift in design theories over time through Space Syntax, and suggests that isolation was progressively built into urban layouts.

" The disabling effect of the urban transformation had the greatest impact on the weakest and least powerful people socially; those who depended on their local environment the most to support them in everyday life like children, elders, the sick and the disabled, the unemployed" (Hanson, 2000).

Hanson looked for and found the empirical evidence in support to Jacobs concerns over the isolation between people in modernist estates.

The spatial justification of the social phenomena resides in the morphological properties of the urban layouts and the resulting lack of accessibility and permeability of the estates.

Also, according to Hanson, the shape of public space (configuration) as well as the way that buildings and space are located in relation to public space (constitutedness) has a great influence on human interaction (Van Nes, 2014), (Remali et al., 2014).

The degree of constitutedness of a street depends on the relationship between buildings and public space; in a street, if the entrances of the buildings open directly onto it, the buildings constitute the street. Conversely, if buildings are adjacent to the street, but the entrances are hidden from the street behind fences, gardens, walls, the street is defined as unconstituted (Hillier et al., 1984).

Both elements, configuration of space and constitutedness, are equally important for the liveliness of pubic spaces.

Hanson and Jacobs agree that the modernist layouts make it more difficult for people to meet and interact, and this is especially true for the people in society who need it the most, children, elderly, women, or people who are out of work. But Hanson is able to support his findings through a methodology, which is able to support urban design and policy decisions; in fact many urban designers and policy makers are nowadays utilizing Space Syntax commercially.

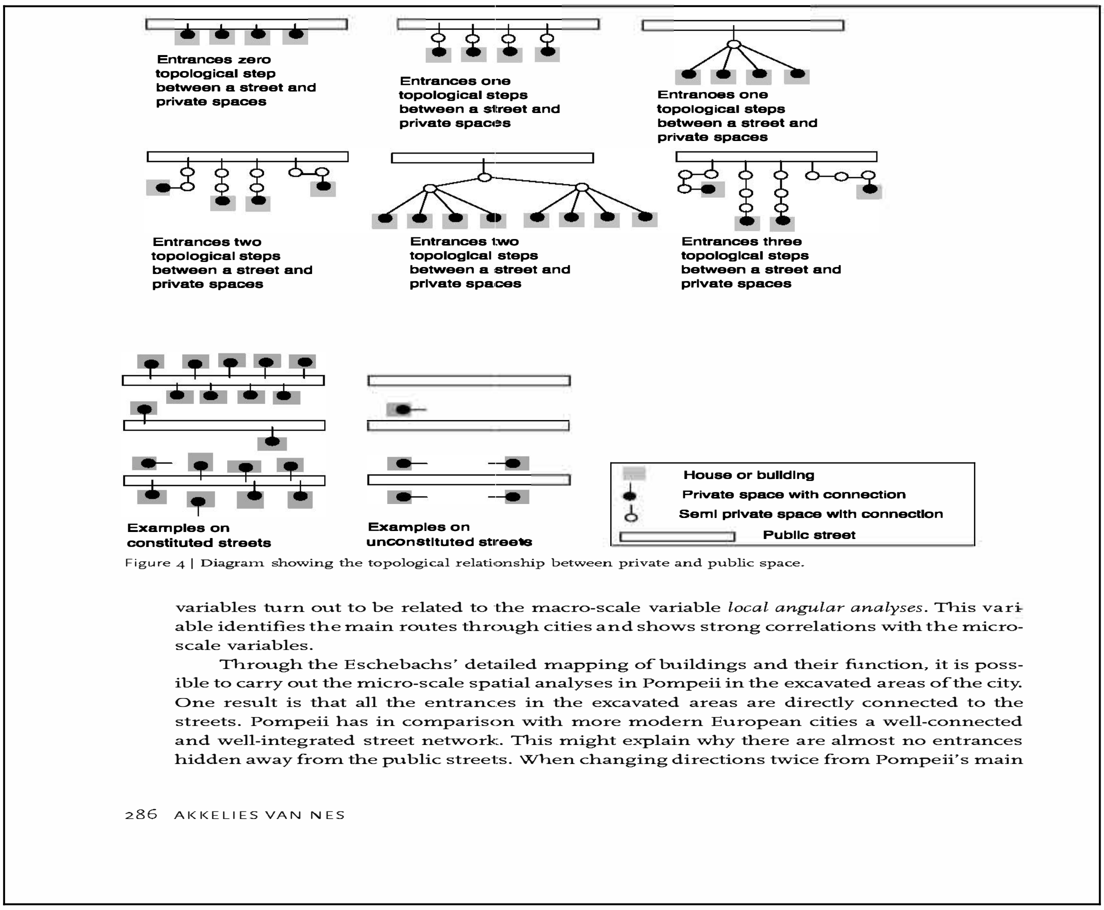


Figure 4 | Diagram showing the topological relationship between private and public space.

variables turn out to be related to the macro-scale variable *local angular analyses*. This variable identifies the main routes through cities and shows strong correlations with the micro-scale variables.

Through the Eschebachs' detailed mapping of buildings and their function, it is possible to carry out the micro-scale spatial analyses in Pompeii in the excavated areas of the city. One result is that all the entrances in the excavated areas are directly connected to the streets. Pompeii has in comparison with more modern European cities a well-connected and well-integrated street network. This might explain why there are almost no entrances hidden away from the public streets. When changing directions twice from Pompeii's main

286 AKKELIES VAN NES

Figure 16. Diagram displaying the different relationships between private and public space (Source: Van Nes, 2014)

3.6. Life in cities

3.6.1. Urban life

Cities and life in cities can be diverse and exciting, as well as threatening and isolated (Valentine, 2008). In this dichotomy lies the complexity of urban living; for a city to be welcoming enough as well as interesting enough a balance between these two counterpoised forces has to be achieved.

The critiques on cities illustrated in the precedent sections demonstrate that environmental and socio economic factors can vary greatly according to historical and geographical circumstances, and so can people's views on whether cities are a good or a bad place to be.

Sharon Zukin acknowledges the importance of urban life and public space as reflection of modern society; cities are no longer though of as centres of production but as centres of consumption and "urban lifestyles" are perceived as a source of cultural vitality and economic renewal (Zukin, 1998).

Public life in public spaces is not unconditionally positive; violence is still a big problem in most UK urban centres, especially during evenings and night; perceived or actual insecurity is a major threat to public life, but so is over control (e.g.: increase in police presence) and limitation of freedom. Again it is hard for local authorities and governments to hit the right balance and insure a successful public life for their cities.

Public life, such as the development of relationships and trust amongst different social groups, can only really happen in public space and to be to be successful has to be based on tolerance.

If a city has large portions of segregated, deprived, isolated residential environments these have to be counterbalanced by a welcoming accessible public urban space (Zukin, 1998).

For Richard Sennett public life is very important as through it people can learn how to deal with complexity and uncover the unwritten rules of public life (Sennett, 1992), (Sennett, 1992). The contemporary city environment has the capacity to turn people outward, to open up towards one another; in this context diversity is key in offering the possibility of exploring the unknown.

Jacobs was one of the first to recognize the important role that the urban layout plays in the generation of urban life and urban qualities. In particular she focused on the different social outcomes of the block city - grid layouts and modernist layouts. According to Jacob the first is more conducive to an active urban life where public spaced and everyday practises are shared.

A thriving public life and the opportunity to taking part to it is especially important for those people who would other ways be excluded from society; and if public spaces are not conducive to co-presence, co- awareness the chances of developing a society based on integration and tolerance are very few.

According to Jacobs a series of very concrete features are required to achieve urban life. The street is the heart of the city, and has to be full of activities and people moving along it, with an essential mix of visitors and residents. Mixed use has to be achieved through land use, different residential tenures and building typologies. Buildings entrances should be directly connected to the public street and short building blocks are preferable to encourage on foot movement.

By comparing the different theories about neighbourhoods planning described in the previous section, it is obvious that they are miles apart from what Jacobs predicates. Modernist urban layouts reflect the idea of activity separation, here is where you live, here is where you work, here is where you shop, while Jacob celebrates the thriving public life that happens when all those activities happen in the same place.

But is a thriving public life the answer to all our problems?

Ash Amin questions the believe that thriving and inclusive public spaces are actually able to improve urban democracy (Amin, 2008). According to Amin interaction in public spaces is not enough to develop public culture because today civic practices are shaped in social networks that are not reducible to the urban (internet, books, television, magazines, etc). For Amin, urban public space is a factor of arguably secondary importance in a rich spectrum of civic and political formation.

Amin, from her post-humanist perspective, admits that “Public space, if organized properly, offers the potential for social communion by allowing us to lift our gaze from the daily grind, and as a result, increase our disposition towards the other", which would not be a trivial achievement at all.

We feel that from an urban design point of vie is still important to work towards the achievement of well functioning cities and public spaces.

3.6.2. Co-presence and movement in space

The reason behind the interest on public life and public spaces is that spatial configuration is able to impact on patterns of movement in space, and movement is definitely the prevailing form of space use.

Hillier claims that patterns of co-presence are defined through movement and thus co-awareness between people living and passing through an area depends on patterns of co-presence.

Human behaviours such as dwelling, interacting, encountering, are not attributes of an individual but patterns of configurations determined by groups of people. Such behaviours depend on engineered patterns of co-presence or co- absence (Hillier, 1996).

According to Hillier " the relation between space and social existence does not lie at the level of the individual space, or individual activity. It lies in relations between configurations of people and configuration of space" (Amin, 2008) (Hillier, 1996).

Patterns of co-presence and co-awareness are the result of spatial design and thus the effects of spatial form on people's behaviour are both limited and specific.

If space is badly designed it could be left empty or it could be badly used leading to fear and discomfort.

Hanson adds that co-presence is the precondition for face to face human interaction among people of different ages, genders, culture and ethnicity; mixed co-presence and mixed space use is fundamental for urban vitality (Hanson, 2000).

Gehl and their investigations on how people behave and react to different public spaces further support the above views about the importance of public vitality and life in public spaces.

In this light we can substantiate the argument that the configuration of space can support design decision aimed at avoiding, mitigating, or even relieving communities from segregation issues and thus developing this subject further in this PhD thesis.

4. Spatial Modeling and MCA

4.1. The structure of the urban fabric

How can the spatial dimension –the role played by space configuration- of indexes such as QoL or deprivation be captured in such way to contribute to Urban Design?

We argue the need of a new spatial based approach in order to explore the role of space configuration in matters of urban design a new approach that departs form the already explored context of social and urban sociology.

As we aim to really understand how changes in the built environment, and particularly in the urban form, can affect social outcomes, we have to focus on the relationship between the physical and the social city.

In the following sections we will review the approaches adopted by different research fields towards the description of urban space and understand if these provide enough information on how urban design can play a role in addressing Quality of Life, deprivation and segregation issues.

4.1.1. Geography/ Spatial Modeling

Indexes such s the Scottish Index of Multiple Deprivation (SIMD) are usually communicated through an extensive use of mapping describing the composition of different areas through their social profiles. Indicators are normally focused on demographic composition, health, working conditions, income, education levels, criminality, accessibility etc. (Scottish Government, 2011).

The level of Deprivation is then established by relative comparison between different datazones.

The first difficulty encountered by an urban designer who would wish to use the SIMD as guidance is the lack of definition of adequate geographical areas such as the neighbourhood, the block or the street. Data is aggregated at datazone level, a geometry defined on paper, which does not bare any link to the real city in terms of physical barriers or perceived neighbourhood boundaries. Also datazones cover far too big an area to be able to offer any guidance eon what really happens in a block or along a street and have not been defined under any configurational or morphological perspective.

As a result indexes such as the SIMD are of very little help to Urban Designers as they explain very little of how the built environment influences social outcomes and are also not able to facilitate any in depth further studies to link spatial properties to segregation.

Different land uses such as the amount of green space, vacant and derelict land or commercial/ office areas might influence the data displayed in the SIMD, but these factors are not made obvious.

We have already mentioned that the definition of the geographical units does not bare any relationship to the city on the ground, and this often results in units that are completely arbitrary in respect to the problem analysed. This in turn will influence the observed patterns, relationships and statistics.

Often units are then studied in isolation, which would be unthinkable under an urban design perspective, where relations between different parts of the city are essential to the understanding of a city as a whole.

As a consequence geographical descriptions of issues like deprivation (or low QoL) present a top down perspective which is logical under an administrative point of view, but does not take cognisance of the spatial relationships of the urban layout at all (Marcus, 2008).

Relationships between buildings, streets or neighbourhoods are completely absent, and the data present in the studies cannot be disaggregated at a smaller geography; as a consequence very little information to the Urban Designer is on offer through such approach.

4.1.2. Urban Morphology

Urban space is described very differently though an urban morphology perspective.

The theories behind urban morphology evolved from three schools, the English, the French and the Italian. The English school concentrated on the study of settlements at very small scale, the French on the relationship between society and space, and the Italian on more strictly architectural aspects, such as the study of the evolution of building types to support new designs (Marcus et al., 2011).

All schools insist on the idea of evolution at different scale and are based on three main principles (Moudon, 1997):

1. Urban form is defined by the following elements:
   - Buildings and building typologies
   - Open space
   - Plots
   - Streets
2. Urban form can be interpreted at different scales:
   - Street/block
   - Building/plot
   - The city
   - The region

3. Studies of urban form adopt time as an important variable

Urban geographers and urban morphologists agree on the lack of an approach able to convey the description of the city as it is experienced at eye level (Talen, 2003), (Gauthier et al., 2006), (Marcus et al., 2011).

4.1.3. The formation of Deprived Neighbourhoods

Research literature presents many different ideas on what deprived neighbourhoods are and, most importantly, on the reasons behind their formation.

European scholars suggest that the existence of such areas can be explained through layered processes of segregation, social exclusion and increasing poverty in urban settlements, which in turn ingenerate spatial concentrations of "pockets of poverty" (Unit, 1998).

If this were true the formation of deprived neighbourhoods should be a direct consequence of economic circumstances but in real facts there does not appear to be a direct connection between positive fluctuations in the national or local economy and enhancements of conditions in deprived neighbourhoods (Mumford et al., 1999); the recognition of this lack of connection is reinforced by Hall who claims that "external factors cannot explain why particular estates are impacted upon more severely than others" (Hall, 1997).

It is generally accepted that deprived neighbourhoods and urban decay initiate when the less wealthy concentrate in the least attractive parts of a city; but it is very difficult to explain why some neighbourhoods perform worse than others, because the relationship between the initiation of urban decay and the formation of deprived neighbourhoods and social segregation is very complex, dynamic and multi-layered.

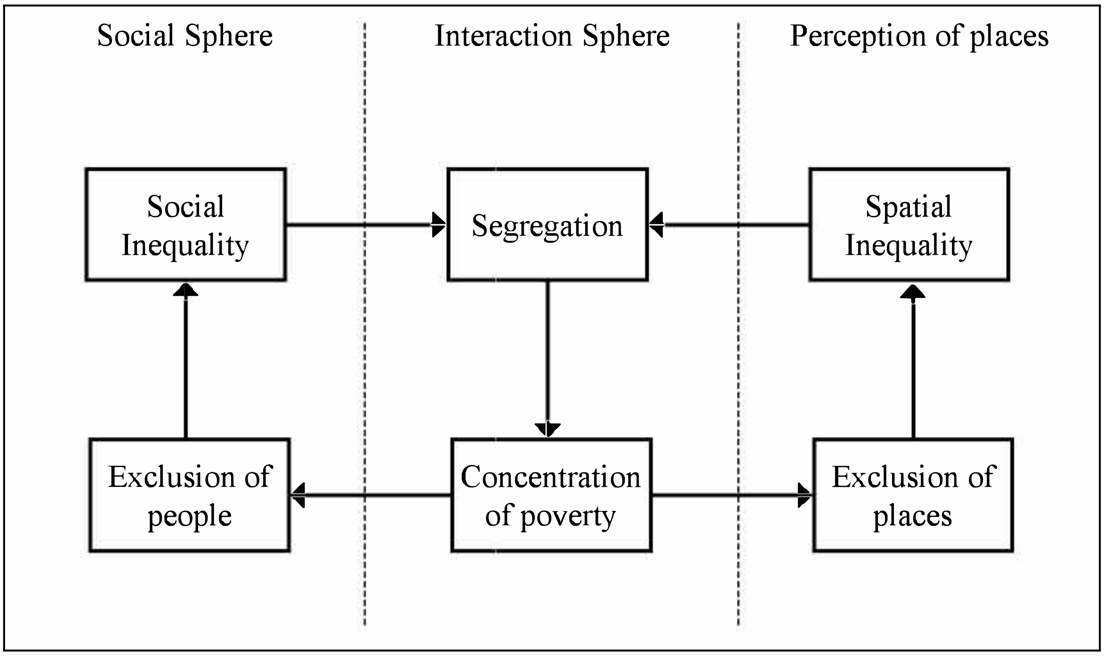


Figure 17. Model of the interaction between segregation and the formation of deprived neighbourhoods (Andersen, 2002).

The model proposed by Hans Skifter Andersen in Figure 17 explains the circularity of the process of Segregation, where the Concentration of poverty can cause Exclusion of People, which leads to Social Inequality and Segregation, but also to Exclusion of Places, which in turn would lead to Spatial Inequality and, again, Segregation.

This model describes the self-perpetuation of negative social environments occurring in many deprived neighbourhoods which is very hard to reverse and could constitute one of the main factors behind the resilience of areas of segregation (Taylor, 1998).

The debate on segregation concerns many major political areas such as employment policies, (uneven distribution of work opportunities amongst different social groups), education and social housing as well as urban design and town planning related policies.

It is difficult to compare the problem of segregation amongst different countries because of the different types of welfare state and urban histories; approaches to the study of segregation vary, as European research tends to focus on social and ethnic differences, Latin Americans on class difference, Australians on first and second generations of immigrants and the US on racial segregation.

Generally speaking levels of segregation are lower in Europe than anywhere else; neighbourhoods offer a good social mix, with the exception of low-income households in British cities (Musterd, 2005), where segregation often occurs in the much-criticized housing estates developed in the sixties and seventies to address post war social housing demand.

In the UK therefore social segregation has been often addressed through housing policies with an effort to achieve a higher mixture of private and social tenures but without really addressing the relationship between segregation and the built environment (Kleinhans, 2004).

Most research in urban segregation has its roots in sociology and relies on classic descriptive statistics which describe the constitution of different areas in a city through indicators such as income, education, employment, ethnic origins, etc (Musterd, 2005). More recently geographers have been researching the spatial dimension of segregation aided by the development of geographical information systems (GIS) able to process data at a speed which would have been inconceivable only a couple of decades ago (Longley et al., 2003).

In particular the exploration of the role of the structure of public space in segregation is now taking centre stage; this suggests that a more effective approach to urban regeneration should evolve from policies focused solely on social housing to policies targeting the spatial dimension of social segregation (Marcus, 2007).

The necessity of investigating poor QoL, or deprivation, or social segregation through a multi levelled approached is certainly reflected within the last generation of planning policies, but the role played by space, and in particular by the geometry of space, still has to be developed further.

4.1.4. Urban segregation and space

Urban settlements often present areas with a persistent history of deprivation ((Evans et al., 2001) which historically been analysed through research on the social causes of poverty; today new research is investigating how the physical characteristics of neighbourhoods impact on the social outcomes of its inhabitants, trying to unveil the relationship between urban form and urban segregation (Sampson et al., 2002).

The link between social outcomes and urban design or urban form itself is difficult to define.

Hillier, for example, is concerned with developing a better and deeper understanding of how the built environment influences people's everyday lives and stresses the necessity of linking design theories to social theories, as very little is known on how the built environment is able to influence our living and working patterns.

Julienne Hanson suggests that different design solutions lead to specific preconditions for sociability; the research highlights how housing estates developed in the 1960s, tend to isolate people from each other, both at neighbour and neighbourhood level, achieving exactly the contrary of the purpose they were built for, creating a sort of non community where human relationship are hard to develop. Hanson identifies a shift from the "doorstep" culture, where meeting spaces where casual and informal to pre-arranged and highly formal social spaces, where especially the more vulnerable strata of the population, feels more isolated (Hanson et al., 1987).

Jan Gehl has an even more people focused approach to analysing space; Gehl investigates how people use space in different built environments by defining three main sets of activities: necessary activities, optional activities and social activities. Activities can be carried out at different intensities, from low, such as watching and hearing, to high, such as friendship v. What is really important to Jan Gehl is to be able to categorize how people behave in space in order to observe the unwritten rules behind the functioning of urban environments.

At the centre of this theory is the idea that people are more important than buildings itself, and that the focus should be shifting from the architecture to the study of places, of what happens between the buildings, of what encourages people to walk around their cities and of the elements that would lead to a social integrated urban life (Gehl, 2011).

Vaughan and Arbacci agree that segregation is not only a purely residential phenomena as the public realm, the streets, the parks and other urban public spaces are more meaningful sites of segregation in people's everyday lives than residences (Vaughan et al., 2011).

Public spaces are an important element of the urban experience, being the places where people can meet and interact, build relationships and develop place or group identity.

In particular, the spatial configuration of public spaces, influences patterns of movement in space and movement is by far the dominant form of use of space.

Legeby also suggests that social segregation is related to segregation in public spaces and insists on the importance of understanding how urban form is able to influence these conditions in order to be able to overcame or prevent some of the consequences of segregation through Urban Design (Legeby, 2010).

Of course space is not the only way to explain segregation; “even if space has an explanatory power over the formation and persistency of deprived areas, it is not replacing other explanations” (Vaughan et al., 2005).

Often social and spatial processes of inequality and segregation are considered to be interchangeable; concepts such as dual city, social polarization and underclass define the relationship between life opportunities and the behaviour of people in the environment that surrounds them, indicating that spatial distance between different ethnic groups leads to their segregation (accentuating the negative perception of ethnic concentration commonly known as ghettos especially in the US) (Van Kempen, 1994).

This concept limits the idea of space into distance, and adopts this factor as a determining factor in segregation; as a consequence it produces the policies of dispersal and mixing which often have been employed on both sides of the Atlantic to achieve mixed tenures in neighbourhoods in order to break the circle of segregation and lead to a more inclusive society (Friedrichs et al., 2003).

Policies enforcing social mix within neighbourhoods have been accused of being too inflexible and of ignoring the complexity of individual patterns of social interaction, and of not being able, per se, of mitigating segregation (Cole et al., 2000).

In fact, according to Lindo "even in highly mixed neighbourhoods one may only have contact within one's own group" (Lindo, 2005) while Galster et al argue that such policies should adopt a more nuanced approach than simply dividing people according to income (Galster et al., 2010) without taking into account any special circumstances. The lack of success of dispersal policies is demonstrated by the fact that a better mix of the financially disadvantaged with better-off individuals or families does not seem to be leading to greater social mobility (Darcy, 2010), (Wilson, 2012); this suggests that clustering does not equate to ghettoization and that the dispersion of the cluster is not the right way to address the issue (Vaughan et al., 2011).

In order to achieve a more nuanced understanding of cities, migration and settlement patterns, we return to the role of public space as a place for encounter where social mix can and should occur.

According to Hanson and Hillier (Hanson et al., 1987) individuals are members of two different social grouping:

- Spatial groups – defined by geographical proximity
- Transpatial groups – defined by common interests of backgrounds (members of a church, ethnicity, etc)

Public spaces have to be structurally able to support and encourage encounters between the two social groups, to enable the formation of the raw material of society through the pattern of everyday life, the chance encounters in the streets or the children at play in the square (Vaughan et al., 2011).

Hillier argues that society is both constrained and recognizable through the form and order of physical space, whether designed or organically developed through time, and that such space constitutes a system, whose working mechanisms can be studied and unveiled (Hanson et al., 1987) and can lead to a better understanding of how cities work.

Jacobs has almost a normative approach in her outlook on the built environment, as she reckons that certain conditions such as street vitality, clear demarcation of public and private property, land mix, are indicators of the social outcomes of a certain area (Jacobs, 1961). Spatial properties are clearly linked to social outcomes.

Sennet proposes a causal explanation where the privatization of public space that often happens in modernist layouts increases the chances of segregation because people have less space for interaction (Sennett, 1992).

Often deprivation studies do not focus on the fixed factors related to the built environment important to Jacobs and Sennet, such as level of services, ground floor uses or public space availability, but do concentrate on dwelling type and tenure.

As a result policies recommend social mix as a way to resolve deprivation or social segregation, but this alone has proved not to be an effective way of action.

This thesis will investigate how more detailed spatial analysis can give an insight and guidance on new approaches to regeneration.

4.1.5. From a birds eye view to a street level experience

Policies addressing issues of deprivation very rarely include urban design or planning aspects, and when they do, actions are limited to housing projects or superficial upgrades of public spaces, and never address the issue of space configuration.

Intuitively it is easy too see that surroundings have a great impact on how human beings experience the city, but previously morphological geographical approaches have failed to convey how the configuration of space can affect social relations.

That is how the configuration of space can affect flows of movement, co presence in space and access to facilities.

This thesis shifts from a birds eye view of the city to a street level approach, where the human experience of the built environment is the key that unlocks the problems (Whyte, 1980).

Street level spatial approach changes the way we determine boundaries, no longer based on lines on paper but based on the experience of the built environment.

The Copernican revolution on how as urban designers we look at our cities implies an analysis of the urban system based on how spaces are related in reality, at ground level, and aims at integrating the human experience in public policies and procedures.

SS or the MCA are two different approaches able to describe spatial relations and embrace the shift from location to relation, where the investigation focuses on distributions of and through space rather than on distributions in space (Legeby, 2010). To elaborate further:

- Distribution in space: the attention is on location, whether it is of services, amenities, or of groups of people.
- Distribution of space: the attention is on space configuration, on how space is determined by the built environment.
- Distribution through space: the attention is on how space is used by people, how activity is distributed in the built environment.
- In this research the configurative approach is at the basis of the investigations on space and social outcomes.

The configurational approach is not the answer to all deprivation problems, as it is only able to describe the potential within the urban system.

But this is no small thing. In fact, if we think of our cities as the stratification of a series of levels, we can imagine that the configuration of space is the first layer upon which all the other layers are overlaid on. But if the first layer is not fit for purpose the other elements will not be able to function as well.

In this thesis the study is extended to investigate many different aspects of the built environment such as the presence of commerce and services, variation in rental values, as well as the adoption of socio economic indicators for deprivation based on NHS (National Health System) data regarding methadone prescriptions, and their relation to the distribution of space.

The analysis aims to establish how inequalities in living conditions can be influenced by space configuration and departs from the idea of affordance as what the environment provides to animals or humans, whether positive or negative (Gibson, 1977).

The concept of affordance can be translated into the urban environment as to which spatial advantages can an area afford its residents from its residents point of view (Maier et al., 2009).

For example a spatially segregated area could appeal to some people (houses located in cul de sacs appeal to families as the absence of passing though traffic allows children to play safely on the street) but could be a problem for some other people (elderly people who would have to walk longer distances to services due to the lack of direct routes), hence the importance of the end users point of view.

This shift in focus requires the reformulation of the research questions.

The first question deals with how space is described and theorized in relation to concepts like Quality of Life, deprivation or segregation and warnings against a purely configurational approach have just been listed.

The second question is about how concepts like Quality of Life, deprivation or segregation can be analysed from a different perspective able to fully acknowledge the role of urban design. The shift of focus from spatial locations to spatial relations is the pivoting point of this question.

A third question involves the adoption of the configurational approach to the problems of Quality of Life, deprivation or segregation with the aim of reaching a fuller understating of what is the role of space configuration; such knowledge should be able to support urban design and planning decisions in policies aimed at improving Quality of Life, deprivation or segregation. The idea that space is able to influence social outcomes could and should stimulate further debate on social sustainability within spatial urban networks.

The MCA approach is found to be a relevant theory and methodology to address the research questions; it is a configurative morphological tool that unveils the structural level of urban form and focuses on the relation between spaces.

Like in the case of Space Syntax this means that QoL, deprivation or segregation can be studied dynamically through the analysis of how people are connected through space rather than statistically averaged across space (Marcus, 2007).

It is how things are put together that really matters (Hillier, 1996); MCA provides quantitative results that can be correlated to other variables in the real world, such as presence of commerce (Porta et al., 2009), rental values and methadone prescription as illustrated in the case studies contained within this thesis.

4.2. Multiple Centrality Assessment (MCA)

4.2.1. Introduction

4.2.1.1. Why MCA?

The impact of urban form on social outcomes, such as low QoL, Deprivation or Segregation, or persistency of social malaise in certain areas has been explored in the existing literature through different approaches.

Laura Vaughan and her team at Bartlett University in London developed a methodology based on space syntax theories and tools to relate urban form to social outcomes (Vaughan et al., 2005), (Hillier et al., 2007), (Vaughan, 2007), (Vaughan et al., 2005), (Vaughan et al., 2011), (Vaughan et al., 2005), (Legeby et al., 2011), (Marcus, 2007), (Marcus, 2008).

The research on Quality of Life to support this PhD highlighted how Scottish Government created the Scottish Index of Multiple Depravation to measure the lack of QoL or well-being. Deprivation, social inequalities and segregation are fundamental concepts in Laura Vaughan's work, which explores the relationship between urban form and social outcomes.

Vaughan's paper "Space and exclusion: does urban morphology play a part in social deprivation?" (Vaughan et al., 2005) was fundamental in developing a research structure aimed at studying socio economic indicators in relation to urban morphology indicators. Vaughan analyses historical socio economic data surveyed by Charles Booth during the last decades of the nineteenth century, together with contemporary deprivation indexes and Space Syntax measures of spatial segregation; it aims to reveal the spatial processes involved in the creation and the persistency of poverty areas in London.

According to the authors one of the main difficulties to the study was the impossibility of accessing contemporary fine grain urban data due to privacy issues.

As a Glasgow City Council employee though I had access to urban fine grain data and Sergio Porta et al. were working on the Multiple Centrality Analysis (MCA), a methodology able to produce quantifiable urban configuration indicators with a different technical approach from Space Syntax at University of Strathclyde where I had started this PhD.

The methodology developed for my research was able to combine the two factors, contemporary urban fine grain data (duly anonymized) with urban configuration indicators developed through the MCA.

My research aims to address the gap existing between the aspirations of high-level urban policies, such as Designing Streets (Scottish Government,), and what is delivered on the ground.

If Urban Form and Street Patterns are material for consideration in policy, why is the focus on these issues lost on the way to delivery?

How can the link between urban data with urban morphology indicators support the closure of this gap?

Anne Shepherd suggests that problem based learning (PBL) can be effective in reducing the gap between planning education and practise (A., 1992); I am hopeful that the case studies developed for this thesis will be able to demonstrate the importance of urban form in the design of successful places.

The spatially based approach of this study opens new possibilities for discussion on phenomena that had previously been analysed only from socio-economic points of view.

Why are certain streets more successful than others? How can we relate indicators of deprivation to urban morphology indicators?

The PBL approach was specifically adopted to encourage the bridging of the gap between theory and practice; the case studies contained within this thesis, and in particular the data sets adopted were chosen because of their relevance, and because of their availability, as the retrieval of fine grain data is not a problem that can be overlooked.

In the following sections I will present a brief literature review of the MCA tool followed by a description of its outputs.

This thesis will not focus on the mathematical and statistical aspects of the algorithm developed for the tool, which can be explored in further detail in the research referenced, but on the qualitative aspects of the tool, and on the significance of its outputs in relation to urban design.

4.2.2. Literature review

4.2.2.1. Urban Form and Urban Morphology

Urban Morphology is the field of studies that focuses specifically on the definition of what is urban form and what is its role in cities; it was funded between the 1940s and 1960s by a British urban Geographer, Conzen, and an Italian architect, Muratori who investigated the urban fabric at different scales, such as neighbourhood, street, plot and buildings (Moudon, 1997).

In more recent years, starting from the late 1990s, a collaborative integration of space syntax into GIS offered new perspectives to the development of urban morphology studies.

The conventional geographical models and modelling concepts used within GIS had to be extended towards some alternative cognitive-oriented models that support the way humans perceive and act in their environment. In the context of a collaborative integration between GIS and urban morphology, such an analysis is important as some of the modelling concepts used within urban morphology belong to such a class of alternative views of space.

This steps facilitated the connection between urban morphology and the science of complex systems, analysing complexity in the built environment with the same tools previously utilized to investigate other self-organized phenomena in nature, technology or society (Jiang et al., 2002) (Anas et al., 1998), (Batty, 2005).

Such complex systems like phone networks, power grids, social media networks, or indeed street systems, are very often structured as planar networks, where nodes and edges are located in particular locations in space; being able to characterize the structure and the evolution of such spatial networks has proven to be a crucial step for the advancement of many different research fields, including urban studies.

Graph theory had been applied to the study of regional transport networks since the 1960s (Garrison et al., 1964), but the development of complex system science together with increased computation power and geo-referenced data availability, has seen further developments of this approach in recent years ((Barthélemy, 2011), (Strano et al., 2012), (Boccaletti et al., 2006).

This PhD thesis will focus on the study of street networks and their characteristics through a complex systems and graph theory approach.

Studies of structural properties of networks were conducted and still are being developed through different methodologies for cities across the world.

Masucci at al (Masucci et al., 2009), for example, analysed the street network of London through three different models based on a grid, a statistic random planar graph and a growing random planar graph, to conclude that the streets of London form a self organising system whose expansion is ruled by the collaboration between the metrical and informational space.

Through a different approach Jiang (Jiang, 2007) derived a topological urban street network of 40 American cities to discover a network behaviour comparable to a small world structure with scale free properties.

The approach we propose in this research is based on the concept of centrality, which we will illustrate fully in the next section (Crucitti et al., 2006), (Hillier et al., 1984), (Porta et al., 2006). Although the notion of centrality is fundamental both to the Space Syntax (adopted by Laura Vaughan and her team in the aforementioned papers) and MCA (adopted in this thesis), we will explain how the two methodologies differ in their translation of the built environment into the graphs utilized in their analysis.

4.2.3. Centrality

For those of us who live in cities, or work with cities, the idea of centrality comes almost natural; central areas in cities are associated with easy of access, density of retail and facilities, popularity and visibility.

Central places tend to attract a higher number of visitors and have a higher chance to play an important role in a centre's civic life.

Therefore usually museums, theaters, corporate offices are located in the city centre where normally real estate values are higher.

The capacity of central location to sustain higher densities of retail and services is a key factor to the formation of urban nodes (Newman, 1999) and as such centrality is an important factor for planners and city designers.

Centrality is not only an important factor in how urban centres work today, but it also a fundamental factor in the historical development of the city itself (Strano et al., 2012). The centre of urban settlements are usually located at the intersection of two main roads, in a particular point close to a river, or where the terrain presents characteristics that are conducive to higher passing through traffic. Cities develops thereafter around this special location.

This is completely reflected in Glasgow for example; its medieval burgh was a linear settlement along the High Street down to the River Clyde (Lever, 1993) and one of Glasgow's major burghs, Govan, developed at a point where the River Clyde was shallow enough to be crossed on foot, making it an important location for local traffic (Dalglish et al., 2009).

4.2.3.1. Centrality and Networks

In the 1950s structural sociologists started translating groups of people in social or organizational settings into networks, where nodes represented the individuals and the edges represented the relationships that linked them (Wasserman et al., 1994).

Bavelas in particular was the first one to unveil how individuals who occupy a central position in a social network often play an important role in the group, and are more likely to be able to influence the rest of the group.

As a consequence he embarked on a systematic study of social networks and developed a set of centrality indexes, which were later implemented by Freeman in the late 1970s (Freeman, 1977), (Freeman, 1979).

Recent research has highlighted how different complex networks in economic, social, natural man made systems, present similarities in their behaviour.

It has been demonstrated that most of those networks follow the "small world property", that is that the average topological distance between couple of nodes is significantly smaller than the size of the overall network, notwithstanding the fact that such networks present large local clustering typical ofl attices (Watts et al., 1998).

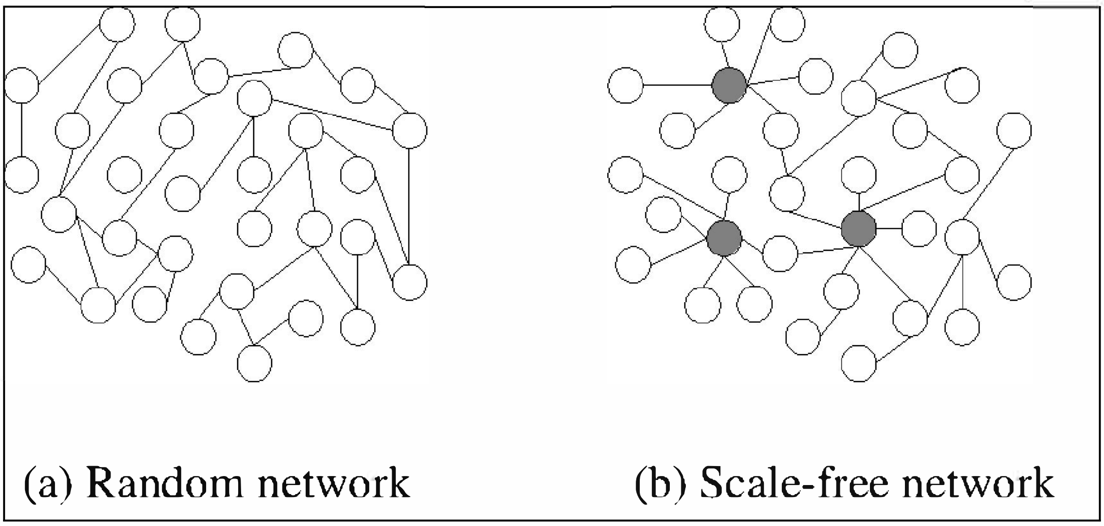


Figure 18. Random Networks and Scale Free Networks (Seo et al., 2013) Most nodes in random networks have the same number of links, while Scale-free networks present a few highly connected nodes which are called hubs (dark circles). Source: (Seo et al., 2013)

Recently, it has been demonstrated that most large networks for which topological information is available display scale-free features, that is they are characterized by the presence of nodes which present a much higher number of connections than the average of other nodes. This characteristic makes them very strong against errors, since just a few nodes hold a central importance (Barabási et al., 1999).

Road networks that have been planned are usually similar to random networks, but road networks which have developed organically present scale free network characteristics. In particular, the concept of centrality in networks has remained crucial to the discussion from when it was first applied to human communication networks by Bavelas in the 1950s.

Since then, the centrality indexes originally formulated by Freeman further to Bavelas research, have been further investigated and developed; in recent years though the accent has shifted from the study of centrality indexes itself to how such indexes distribute along networks.

Centrality translates in urban and regional planning with the concept that some places or streets are more central than others, and is often associated with concepts like accessibility, proximity, permeability, etc (Wilson, 2000).

Concepts like integration and connectivity have been developed in urban design with a particular interest on public spaces, human exchange and liveability; the analysis of spatial systems has been successfully developed since the 1980s though Hillier and

Hanson work on Space Syntax.

Research on cities based on Space Syntax produced growing evidence of the correlation between levels of integration of urban spaces and urban phenomena such as crime rates, pedestrian and vehicular flows, density of commerce and services, and human way finding capacity (Porta et al., 2009), (Hillier, 1996).

Space Syntax presented a profoundly different approach to the study of networks, departing from the previous tradition of transport planning or land use panning, by adopting a dual representation for its graphs.

A primal graph representation translates intersections into nodes and streets into edges, retaining the real world metrical distance between its nodes; a dual graph representation instead translates streets into nodes and intersections into edges: metric distance is abandoned and the resulting topological graph is of rather difficult interpretation.

The Multiple Centrality Assessment developed by Porta and Al, overcomes this problem by adopting a primal graph representation, which is of easier interpretation and can be easily overlaid with different levels of information in a GIS environment (Porta et al., 2006).

4.2.3.2. Primal graphs and Dual Graphs

As mentioned, Space Syntax and MCA develop their study of centrality differently, through a dual and primal approach.

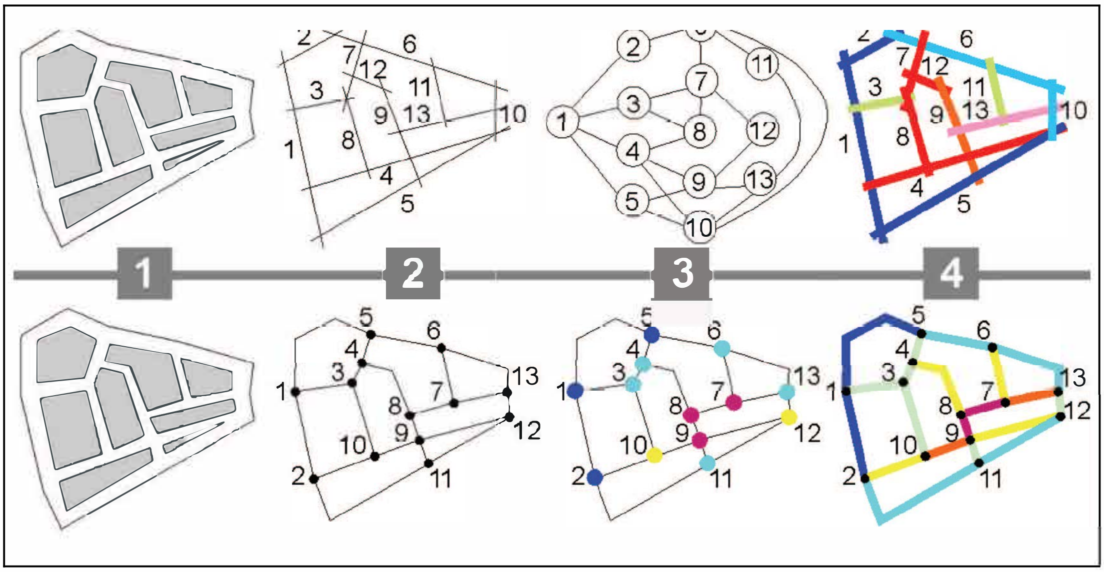


Figure 19. How to construct an axial map (above) and an MCA primal graph (below): the differences are clearly show; in the axial map streets are nodes and intersections are edges, while in the primal graph intersections are nodes and streets are edges (Source: Crucitti et al., 2006, pg 3).

Space Syntax is based on the study of topological networks, where streets are represented as nodes and intersections as the connecting segments (edges) (Figure 19). Axial lines are used to model directions of uninterrupted movement and visibility (Jiang et al., 2002), to represent the longest visibility line in two dimensional urban spaces. A set of axial lines that mutually intersect and cover a free space forms an axial map. The urban environment is analysed through how each vista space is connected or integrated to others. An axial map starts with the identification of the longest visibility line, and intersection axial lines cover the second longest axial line and so on until all the free space.

As we can see in Figure 19 the derivation of the axial map starts from line 1, then 6, then 5... and finally the resulting axial map is used to compute a series of parameters like connectivity, control value, local and global integration. This approach has limitations:

axial lines do not exist in reality so they cannot be represented on GIS; at times axial maps can be so complex to construct that can be applied only to very limited areas of the urban environment.

The MCA instead adopts a primal approach to represent the structure of the city; intersections are represented as a set of points or nodes, linked by a set of lines, or edges (exactly the opposite of the axial map used by Space Syntax - Figure 19). The un-generalized primal graph used by the MCA is in fact a spatial network whose nodes are embedded in a two or three dimensional Euclidean space and whose edges do not define relations in an abstract space but are real physical connections (Cardillo et al., 2006); real distances between nodes are retained by the graph which results of easier interpretation as it retains the shape of the original urban network.

4.2.4. Multiple Centrality Assessment

MCA is a systematized method designed to evaluate the spatial distribution of centrality over geographic networks like road systems at regional scale, urban street networks, areas of activities in public spaces, or traffic flows in in complex buildings such as airports, educational institutions, hospitals and so on.

The first step in working with MCA is the translation of the spatial system in study into a graph, a mathematical entity composed of a defined number of N nodes, and K edges connecting the nodes.

In the case of an urban street network, streets intersections are represented as nodes and streets are represented by edges.

Networks of streets and intersections are defined through the centrelines of the streets; an operation which in the UK is made simpler by the centrelines datasets already available in OS MAPS.

Edges are defined by two end nodes (street intersections) and follow the geographical footprint of existing streets as they are represented in the original map; the distance between two nodes is calculated metrically along the edge (street centreline), retaining the real shape of the street (length, orientation, etc).

Places and connections have been given a conventional definition in the study of the city of Parma, Italy (Porta et al., 2008); a place is an open space when:

1. It presents a convex internal space
2. It presents identifiable edges such as building facades, three lines, changes in pavement texture, railings, etc.
3. Its shorter dimension is less than 70m

Two places are connected when:

1. The smaller distance between their edges is less than 35m
2. They are not separated by physical barriers such as closed railings, buildings, walls, rail tracks, water, etc

MCA investigates how centralities are distributed along such graphs. Centralities are defined through three main indices: Betweenness, Closeness and Straightness centrality; indexes are chosen depending on what notion of being central is relevant for the study being conducted.

A formal mathematical definition of the three centrality indexes can be found in the paper “The Network Analysis od Urban Streets: A Primal Approach” by Sergio Porta et Al (Porta et al., 2005), but for the purposes of this thesis, a more descriptive approach is better suited.

The Betweenness Centrality Index (Figure 20) indicates that a node is central if it lays on the shortest paths that link many nodes with each other; the interaction between two

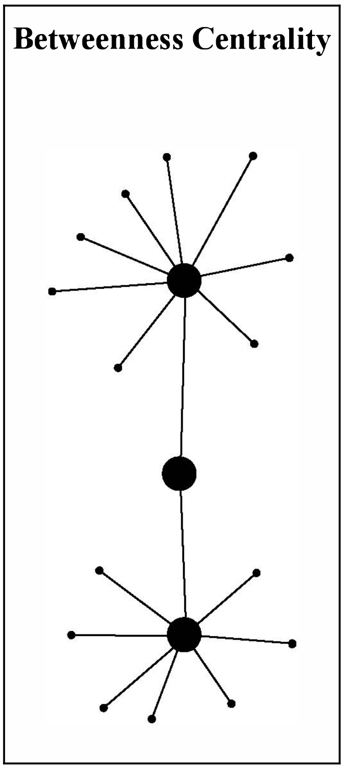


Figure 20. The Betweenness centrality index indicates the likelihood of passing traffic

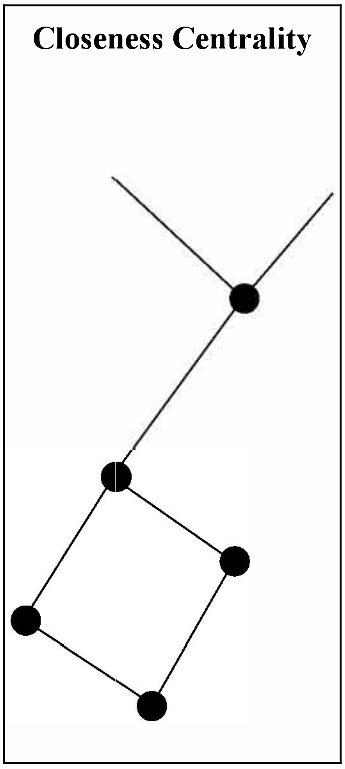


Figure 21. The Closeness Centrality Index measures the accessibility to a node, the closer the node is to the others, and the more accessible it is.

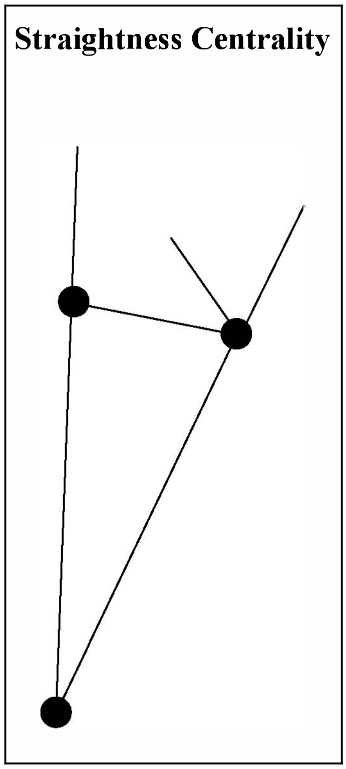


Figure 22. The Straightness Centrality Index indicates the efficiency in communication between two nodes.

faraway nodes depends entirely on the nodes on the path, which become strategically important as they regulate and impact on the flow.

The Closeness Centrality Index (Figure 21) measures to which extent a node is near to all the other nodes in the system along the shortest paths, while the Straightness Centrality Index (Figure 22) is equal to the inverse of the shortest path length between two nodes.

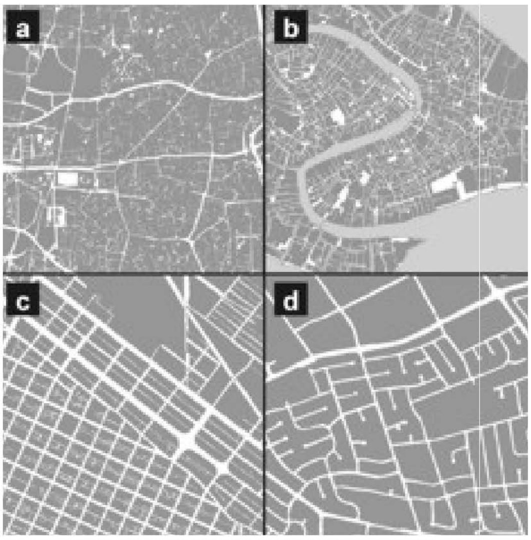
As mentioned in MCA all distances are measured metrically, therefore the distance between nodes is the real distance between the intersections on the street network. This metric concept of distance is used by MCA in all the computations, and indeed in the identifications of the shortest paths.

The adoption of a primal graph, the retention of metric distances and the possibility of choosing between different definitions of centrality deeply differentiate MCA from Space Syntax.

Space syntax adopts a dual graph representation translated into an axial map (Figure 19), and one main centrality index – integration centrality, which roughly translates in the Closeness Centrality index adopted by MCA.

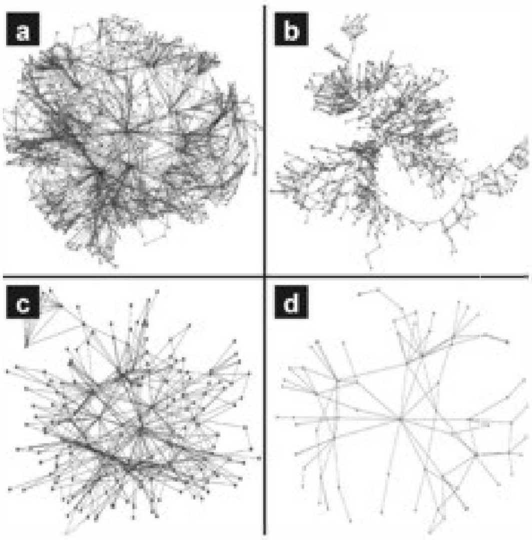
According to Porta and Al (Porta et al., 2008) the advantages of MCA compared to dual approaches like Space Syntax can be summarized as follows:

1. MCA adopts a primal graph approach which results in a model that is more legible and objective



(a) Original maps

(b) Primal Graph: Streets are edges, intersections are nodes



(c) Dual Graphs: Streets are nodes, intersections are edges

Figure 23. Four samples of 1sq mile for four different cities, namely Ahmedabad (a), Venice (b), Richmond-London (c) and Walnut Creek (d), translated respectively in a primal and a dual graph. We note how the original shape of the built environment is lost in the dual graphs translation (Porta et al., 2005).

2. MCA runs over the world geomapping graph format, which means that it can be run over existing urban and metropolitan graphs; existing data can be overlaid and correlated to the distributions of centralities;
3. MCA is able to retain the topology of the system, which is relevant to how people move in public spaces (Hillier et al., 2005), (Joutsiniemi, 2005), based on the belief that spatial layout or structure has great impact on human social activities.
4. MCA is able to convey a multifaceted experience of reality though its different centrality indexes, rather than through a single index like in the case of Space Syntax. That leads to a more tailored indication for action, which can vary from case to case.

In MCA the spatial distribution of centrality indexes over the network is examined graphically through colour coded maps. The resulting maps allow an extended comprehension of the skeleton of the urban network, highlighting major central routes and subareas (Crucitti et al., 2006).

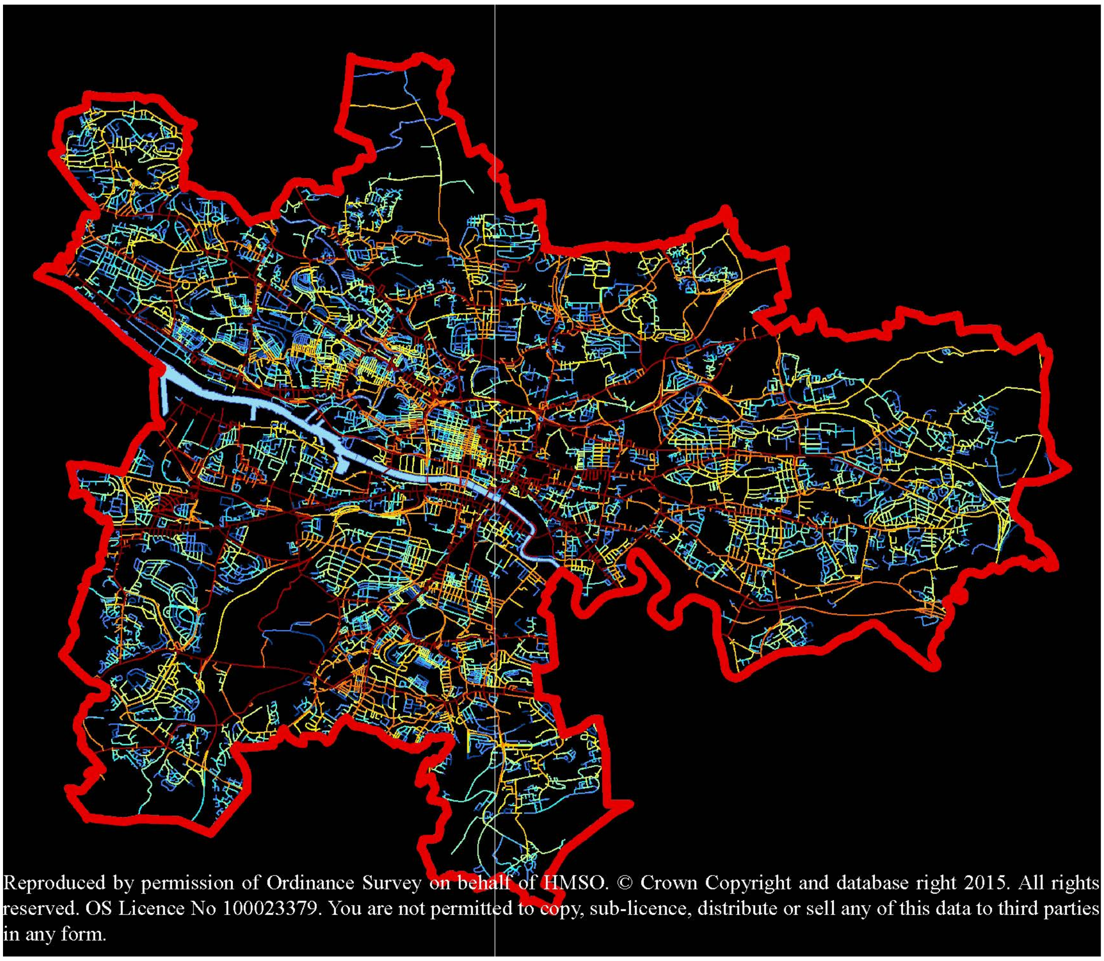


Figure 24. Betweenness centrality index calculated on the urban network of Glasgow. Main routes present high Betweenness index levels and are represented in red; main routes are easily recognizable in the overall network.

4.2.4.1. Kernel Density Estimation

In previous MCA studies, and later in this thesis, Kernel Density Estimations have been adopted to flatten Centrality Indexes results into a smooth density surface of spatial point events over a 2-D geographic space able to allow the statistical correlation between the values associated with such points and indicators of a different nature (such as presence of commerce, etc.) (Xie et al., 2008).

The Kernel Density Estimation (KDE) is a tool for spatial smoothing and or spatial

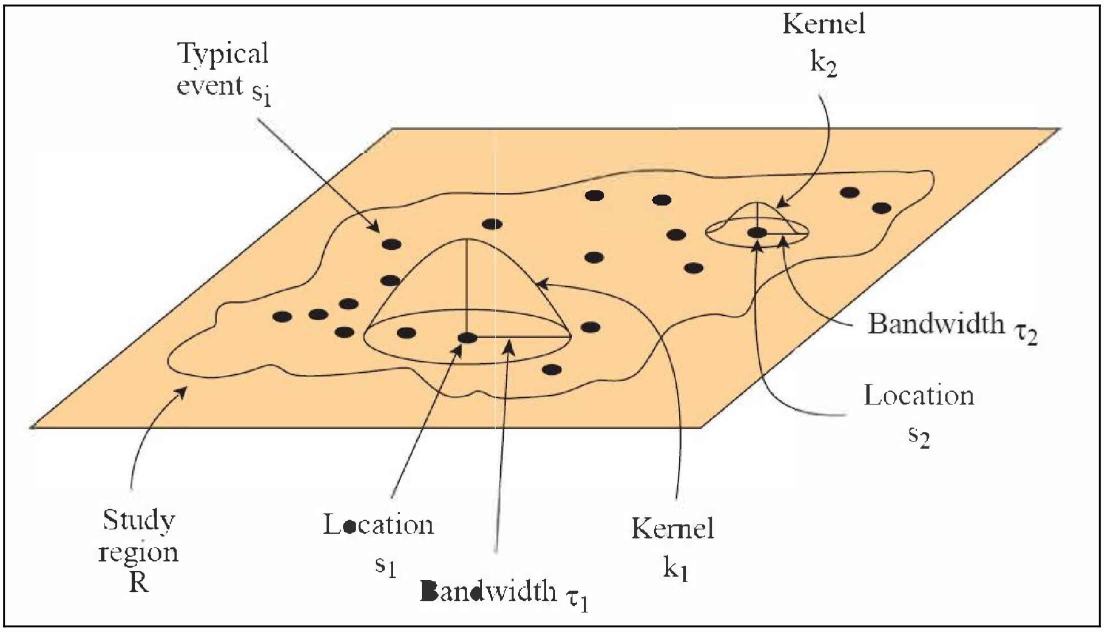


Figure 25. Kernel Density Estimation of a cloud of points (Timothée et al., 2010); the density of a cloud of points is calculated through the Kernel function that weights each event according to their distance from the point within the bandwidth assigned by the user. Within each window the KDE assigns an higher weight to the object that are closer to the centre of the window and a lower weight to the object that are further away (Porta et al., 2009). Through this operation the KDE is able to generate a density of the events (points, e.g. activities, car accidents, crime, etc.) as a continuous field (e.g. raster). A more formal definition can be found in the paper A network based kernel density estimator applied to Barcelona economic activities (Timothée et al., 2010) on page 26. (Source: Timothée et al., 2010, pg 32)

interpolation implemented by several Geographical Information Systems, an in the case of this thesis, by ArcGIS 10.

The KDE balances events according to their distance by calculating the density within a range from each event to represent the value at the centre of the range (Figure 25) can be a useful tool to highlight 'hot spots' or spatial patterns of traffic accidents, street crimes, disease cases, etc. (Okabe et al., 2009), (Anderson, 2009) .

Porta et al adopted this tool for spatial smoothing because it is able to paint a fuller picture of the events at it takes their surroundings into consideration; is readily available in ArcGis and it has the ability of presenting complex data in a clear and visual manner to the non –mathematicians (Porta et al., 2007).

4.3. Space Syntax and Multiple Centrality Assessment: a critical comparison

4.3.1. Analytical approach to the cognitive level of urban space

Space Syntax in the 1970s and the Multiple Centrality Assessment (MCA) in more recent years (about ten years ago) approached the gap in the ability of describing space through human experience, by developing an analytical approach to the cognitive level of urban space.

Space Syntax (SS) investigates the relationship between society and space constructing a theory that includes all the manifestation of the built environment: buildings, settlements, cities, etc.

The concept at the base of SS is that human societies use space as a fundamental resource in organizing themselves and that during this process of organisation the space of inhabitation is configured, that is transformed from continuous into a connected set of individual units.

Such individual units can then be assigned to different groups, people or activities so that then different rules of behaviour and conventions can be related to them. As a consequence the whole SS theory regards social structures as inherently spatial that the configuration of space is based on a social logic.

The relationship between space and society is seen as dynamic, where each influences the other.

The main goal of SS is the development of a theory able to describe the configured inhabited space -buildings or urban settlements- to unveil the underlying social logic, which guided the configuration of the space in the first place (Bafna, 2003).

The understanding of configured space, and especially its formative steps and social meanings are at the centre of SS research.

According to Space Syntax research variations in human movement rates in different places can be justified through spatial configuration, notwithstanding the type of environment, if a building or an urban settlement (Penn, 2003).

The whole Space Syntax theory relies on the idea that cognitive space, the space that supports our understanding of configurations beyond our visual space, is not a metric space but topological.

Such topological relations are transformed into measures linked to the geometrical representations of the system of spaces that is being analysed (Hillier et al., 1984). The elements used to translate the space we live into an axial graph are the axial line to express the linear nature of the visual perception of space (line of sight), the convex space (where interaction occurs), and the isovist (the variable visual field that we perceive from any point in space).

Layouts that translate into shallow graphs are defined as integrated (high accessibility), while layouts that translate into deep graphs are defined as segregated (poor accessibility).

Measures such as integration and segregation are calculated through the graph to describe the whole system and enable urban design research to be both quantitative and qualitative at the same time, in the effort of searching for social and cultural influences/ meanings in the configuration of space (Hillier et al., 2007).

The SS process can be clarified further through its four fundamental steps illustrated in Figure 28:

1. The street pattern is transformed into an axial map, based on the basic spatial unit of the line of sight.
2. The axial map is constructed.
3. The axial map is transformed into a dual graph, denominated connectivity graph, constituted of N nodes (the number of axial lines) and K links representing the intersection between each couple of axial lines. The dual graph is constructed by placing a node in each region of the access graph (Figure 28) with edges linking adjacent dual graph nodes (Figure 28).
4. SS offers different indexes as a means to interpret the built environment but its most significant one is the index of integration. The integration of each node in the connectivity graph is calculated through the SS algorithm and colour coded values are then represented on the axial map.

SS aims to capture both the objectivity of our space and our intuitive engagement with it.

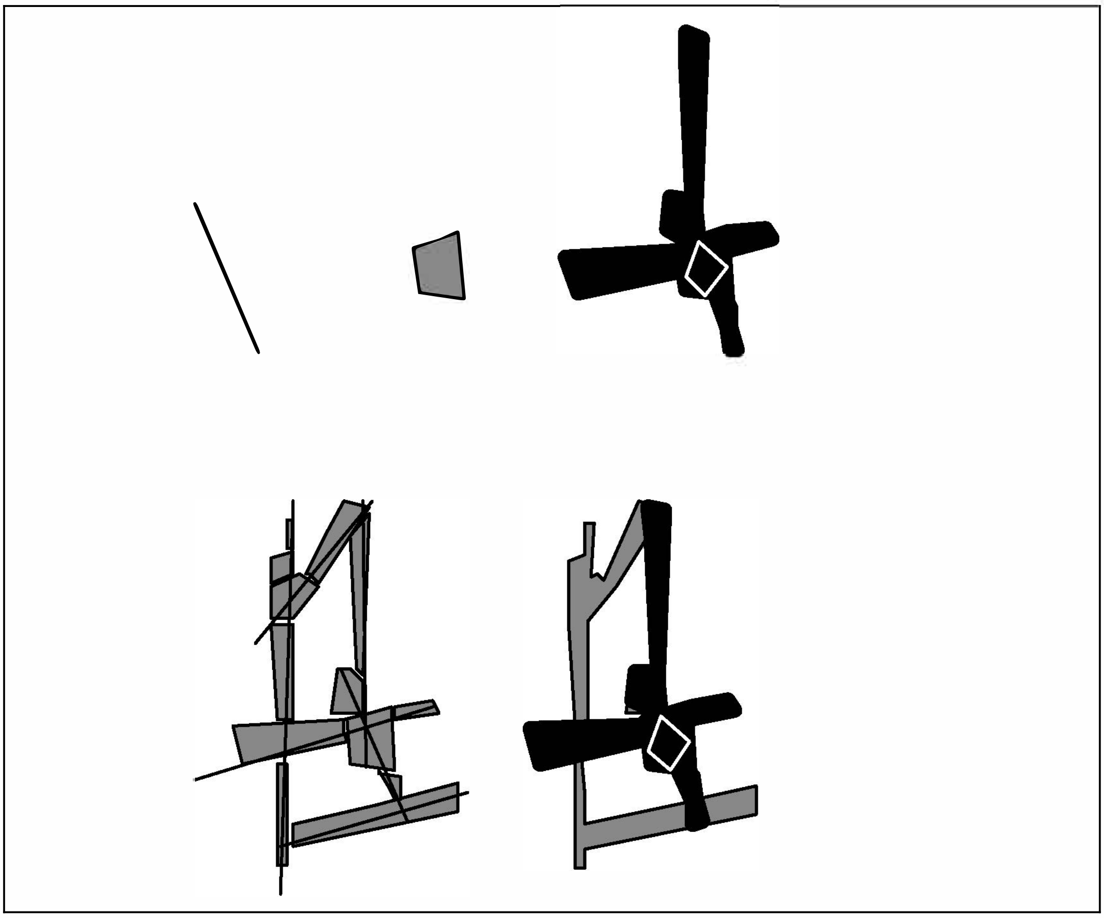


Figure 26. The axial line, the convex space and the isovist as defined in SS (Hillier, 1996, pg 127)

The main feature of SS is the idea that space is analysed with reference to its social potential and this is particularly interesting for the subject matter of this thesis.

For more than 20 years now, research in SS has shown the existence of a significant correlation between the topological centrality of streets, that is streets that present high levels of integration, and increased pedestrian and vehicular traffic, retail and commerce vitality as well as lower crime reports (Crucitti et al., 2006).

Urban form has been showing to have significant potential in increasing QoL, or decreasing deprivation or segregation, and SS theories are able to substantiate the link

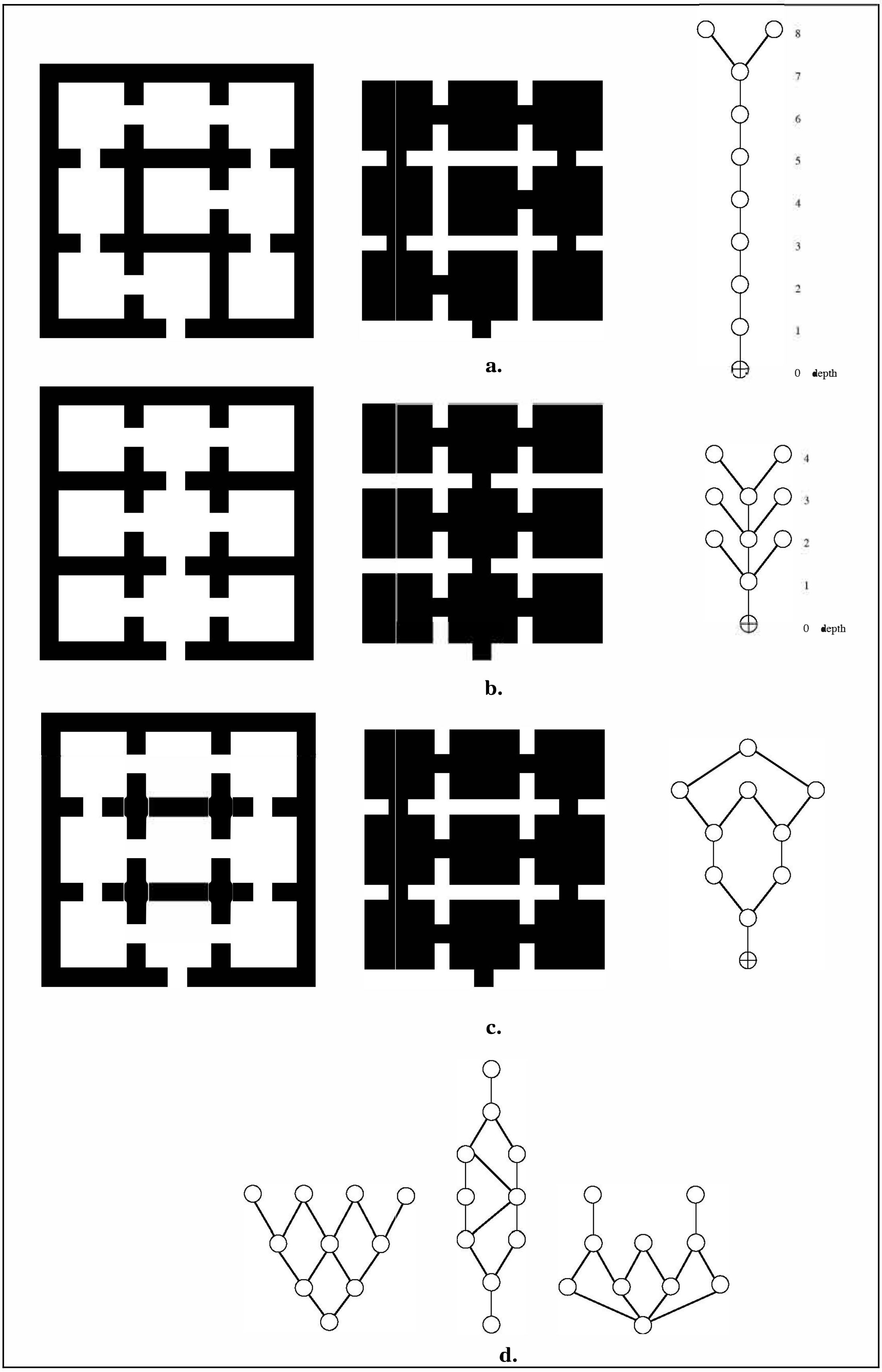


Figure 27. Deep and shallow structures (Hillier, 1996); "it is by expressing these pattern properties in a numerical way that we can find clear relations between space patterns and how collections of people use them." Source: (Hillier, 1996), pg 21

between spatial properties and social outcomes.

According to Carlo Ratti though, the topological representation of the city on which SS is based, discards precious metric information about the city. Ratti suggests that with the significant increase of computational power, it is now possible to gain a deeper understanding of the urban texture based on a full analysis of its topological and metric characteristics. This would also assist in gaining further insight in the question that SS has already framed about the influence of space configuration on social life (Ratti, 2004).

The Multiple Centrality Assessment (MCA), a different methodology applied to the study of urban networks which has been developed in more recent years, is able to fully retain metric information in the translation of the urban environment into a graph (Crucitti et al., 2006).

MCA is the tool adopted to analyse the case studies of this thesis and a full comprehensive literature review can be found in section "4.2. Multiple Centrality Assessment (MCA)".

Both SS and the MCA are tools that can aid research the relationship between urban

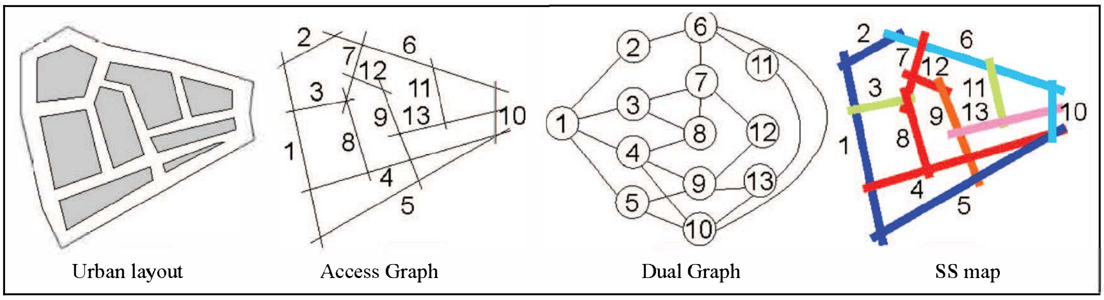


Figure 28. The four fundamental steps of the Space Syntax methodology (Source: Crucitti et al., 2006, pg 3).

form and social outcomes.

In particular this research will be exploring the issues of Quality of Life, Deprivation or segregation in relation to urban form.

How does the urban form influence such phenomena? And more to the point, how can the urban form be changed to aid the resolution of deprivation and segregation?

Pockets of deprivation in our cities are very difficult to shift, Laura Vaughan notes that deprived areas in Victorian London are still disadvantaged today (Vaughan et al., 2005); why is this and most importantly, what is the process behind the formation of areas with such poor social outcomes?

The following section will review different approaches to the resolution of the above question.

4.3.2. Space Syntax and MCA: dual versus primal

The previous sections defined the multiple centrality assessment (MCA), illustrating in depth the methodology for the primal analysis of centralities on urban street systems. This section will focus on the diffrences between 'space syntax', the well-known methodology for the dual analysis of street systems (see "4.3.1. Analytical approach to the cognitive level of urban space") and the MCA.

Previous research both in Space Syntax and in MCA, established a significant correlation between the topological accessibility of streets and phenomena as diverse as their popularity (pedestrian and vehicular flows), human wayfinding, safety against microcriminality, retail commerce vitality, activity separation, and pollution (Penn, 2003), (Porta et al., 2007), but the methodologies presents fundamental differences.

For a start, in MCA networks of streets and intersections are represented by spatial graphs in which zero-dimensional geographic entities (such as intersections) are turned into zero-dimensional graph entities (nodes) placed into a two-dimensional Euclidean space, and one-dimensional geographic entities (such as streets) are turned into one-dimensional graph entities (edges or links). Because of the coherence between the dimension of geographic and graph entities, this representation is defined 'direct', or primal.

In the Space Syntax approach instead, streets are turned into nodes and intersections are turned into edges, thus creation an 'indirect', or dual graph (Hillier, 1996; Hillier and Hanson, 1984).

The first very remarkable difference between the two approaches is that the dual graph does not take distance into account.

Penn and Hall would argue that the importance of distance is questionable in the human cognitive experience of space (Hall, 1966), (Penn, 2003) and as such in SS, no matter its real length, one street will be represented in the dual graph as one point.

The loss of euclidean distances according to Porta et al represents a serious limitation of this approach, as, for example, a lengthy street, with many intersections, could be represented as central (by degree) in a dual graph, while in reality being experienced as the opposite due to distance between destinations (Porta et al., 2006).

Porta et al also refer to the case of via Etnea in Catania, Sicily, a roughly 3 km long, perfectly straight 17th-century street that runs from the baroque city core to the countryside beneath the Etna volcano, a street that exhibits radically different social, economic, demographic, and environmental conditions, and highlight how the dual approach would not account for the differences along it. The same theory would apply to Sauchiehall Street in Glasgow, one ofthe case studies in this research (Case Study: three commercial axis in Glasgow) (Porta et al., 2006).

Gaster and Newman recognize that metric distance is a fundamental characteristic of road networks which leads to key features such as the planar nature and the extremely reduced variance of a node's degree, whose distribution can never recall any particular scale-free behavior (see also Space Syntax and MCA: dual versus primal (Gastner et al., 2006).

By ignoring euclidean distances, the dual graph also ignores the idea of geographical constraint pushing the urban street system out of the geographic domain, making the primal approach a more valuable option.

Research on four 1-square-mile samples of urban street systems performed with primal and dual graphs. by Porta et al , support the primal approach as a more comprehensive, objective, realistic, and feasible methodology for the network analysis of geographic systems such as those of streets and intersections (Gastner et al., 2006).

The primal approach follows the conventional representation of urban networks as adopted by geographers, planners, traffic engineers, etc, and as such is suitable for being analyzed in conjunction with big data developed and available in a broad variety of different fields.

Finally, previous research in MCA, demonstrates that Centrality is not a singular concept, and that th different indexes adopted by this approach, are able to convey different concepts of being central such as being near, being between, being straight to (Figure 21).

To conclude, MCA differs from Space Syntax in its approach as it adopts a (1) primal graph; (2) metric distance; (3) different indices of centrality.

It can be argued that MCA is able to offer a wider spectrum of pictures of reality, and that centrality indexes developed through it can be easily analysed in conjunction with more layers of information on the urban context.

5. Introduction To The City Of Glasgow And Method of Analysis

5.1. Introduction

The previous chapters contained a comprehensive literature review of multilevel concepts like QoL and the Multiple Centrality Assessment.

This chapter will introduce the city of Glasgow, where the case studies are set, the source and extents of the datasets utilized in the research, as well as historical overview of the evolution of the urban centre.

This chapter will also explore the variation of centrality indexes calculated with the MCA across Glasgow's urban network.

5.2. Summary

Glasgow is a complex city which has expanded rapidly during the industrial revolution and then shrunk considerably from the 1970s onwards as a consequence of deindustrialization.

The spatial model and the data analysed for this research was sourced through Glasgow City Council, the Scottish Assessors Association, the NHS and Ship (Scottish Health Informatics Programme). The computers tools employed are Geographic Information

Systems of different nature, ArcGis, QGis and the MCA tool itself.

5.3. Glasgow

5.3.1. Structure of the case studies

The city of Glasgow will be the main object of the case studies for this PhD thesis.

A configurational approach will be applied to the case studies through the employment of the Multiple Centrality Assessment reviewed in section 5.1.

The tools adopted are based on a spatial conceptualization able to convey the users' street level perspective and depart from the classic birds eye view approach.

The areas examined in the case studies will not be studied in isolation, with fixed boundaries, but as a part of the overall city system.

An important aim of the study is to reflect on how changes to a part of the city structure can affect the overall system of peoples' traffic flows; for example, how can the addition of a new path influence the overall ease of movement in an area, increase access to services and facilitate co presence in public spaces; or how could the location of services in area which is not easily accessible affect the overall performance of a neighbourhood.

In the theoretical part of this thesis a strong emphasis has been given to the social outcomes of space configuration and on how urban design could be able to influence such outcomes.

The empirical part will maintain the same focus through the analysis of the relationship between configurational indexes and socio economic indicators such as the presence of commerce and services, methadone prescriptions, poor social outcomes as indicated by the Scottish Index of Multiple Deprivation.

The fundamental question suggested by this approach is: to what extent does a configurational approach contribute to knowledge able to support more effective urban design solutions and encourage polices aimed at improving poor social outcomes through interventions on the structure of the built environment as a fundamental part to their programme?

This thesis will investigate how different configurations of the built environment are able to foster different levels of urban vitality, which in Jacobs' words, is a fundamental indicator of how a neighbourhood performs (Jacobs, 1961).

Four case studies will address both positive and negative aspects of QoL; each case study will be introduced with a brief description of the area in consideration, the choice of configurational and socio economic indicators, as well as the account of how the data contained in the study has been sourced and developed.

Two case studies will investigate the relationship between urban form and two urban features associated with street vitality, a positive aspect of Quality of Life and a precondition for successful cities (Jacobs, 1961) in:

- "6.3. Town Centres and Centrality Indexes"

- "6.4. Commerce and rental values distribution in Glasgow"

The other two case studies will concentrate on the relationship between urban form and two negative aspects of urban life, the concentration of Methadone prescriptions as indicator of poor social outcomes and the persistency of deprivation as indicated by the SIMD in:

- "6.5. Methadone prescriptions as a proxy indicator of deprivation in Glasgow"
- "6.6. Post war housing developments in Glasgow"

The variation of the Centrality indexes of Betweenness, Closeness and to a lesser extent Straightness will be analysed in conjunction to the variation of the socio economic indicators chosen by the author through different methodologies that will be explained on a case-by-case basis in the following sections.

5.3.2. Background and data

The case studies are conducted on the city of Glasgow where the author lives and works.

The intimate knowledge of the city, offers the opportunity to support the case studies through direct experience; also, my role as a Project Manager and Regeneration Officer within Glasgow City Council allows me access to fine grain data, which has already been developed and validated by the local authority.

Glasgow is Scotland's biggest city with 592,820 inhabitants according to the National

Records of Scotland 2011.

Glasgow city Council and Scottish Government have recognized that certain areas of the city of Glasgow have very poor social economic outcomes that have to be addressed. The Scottish Index of Multiple Deprivation highlights how a few areas of Glasgow are the most deprived in Scotland; Glasgow's east end holds some of the worst statistics in Western Europe in respect to health, crime, child poverty, alcohol and drug abuse.

A recent study conducted by the Glasgow Centre of Population Health about the "Glasgow Effect" (Walsh et al., 2010) concluded that the comparison with two other UK cities with similar profiles of deprivation (Liverpool and Manchester) highlights how Glasgow performs worse in terms of mortality (premature deaths in Glasgow are more than 30% higher, with all deaths around 15% higher than in the other cities).

None of the literature existing on the poor social outcomes of certain areas of Glasgow, identified for the scope of this study through the SIMD rankings, takes the built environment into consideration through a spatial configurational approach.

The case studies in this thesis will be analysed through a spatial configurational approach and correlate with aspects of Quality of Life and Urban Policy.

5.3.3. *The spatial model*

A model of the spatial system for Glasgow was constructed for the configurational analysis based on the centre lines shape file contained in the OS maps for Glasgow. The final spatial model consists of 35619 edges and 28907 nodes and comprises a

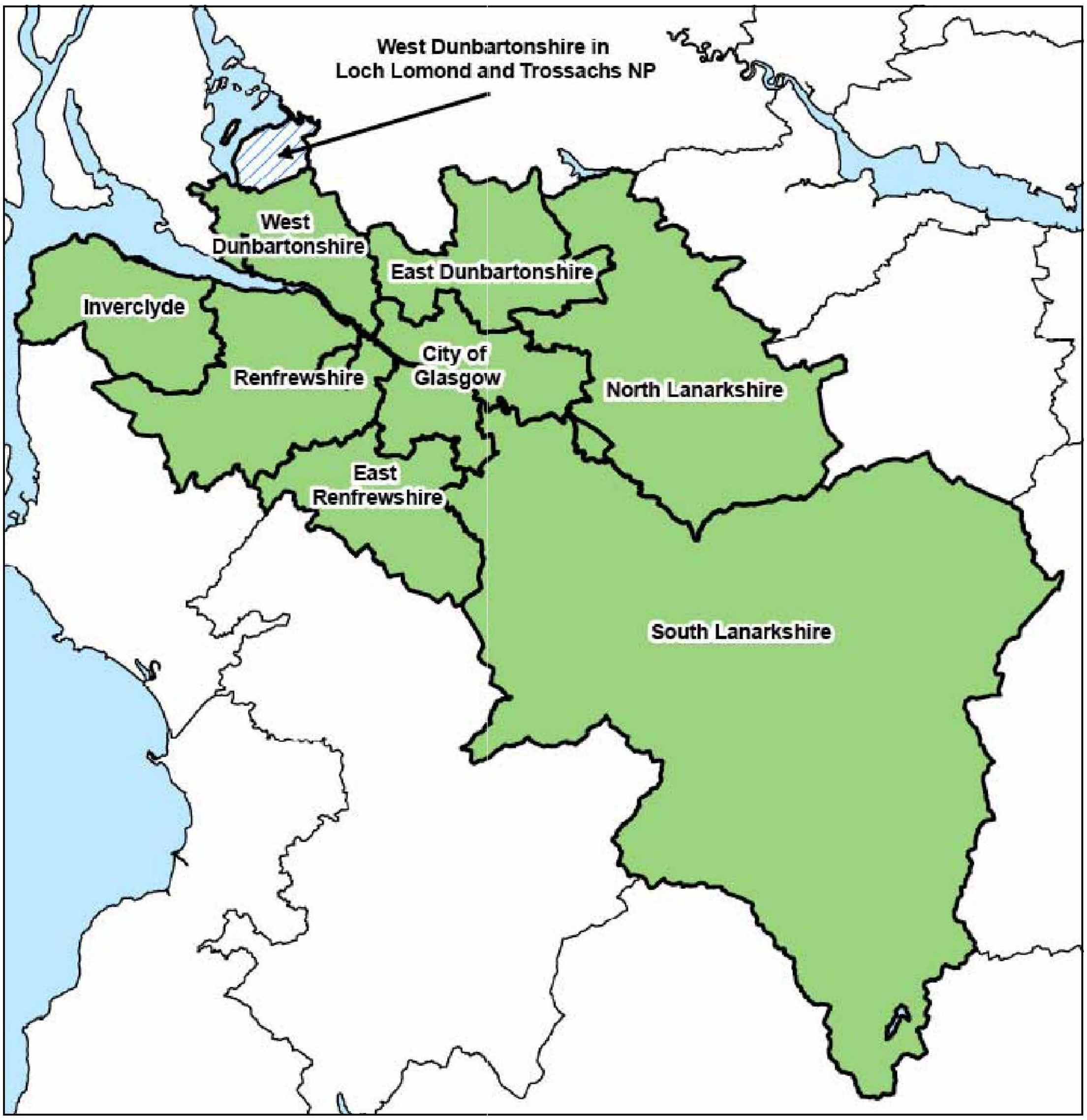


Figure 29. Map of Glasgow and the Clyde Valley Strategic Development Plan Area. The light blue line around the area named Glasgow City represents Glasgow's statutory boundaries, although the conurbation extends seamlessly in each direction in the Glasgow and Clyde Valley area, which is inhabited by 1/3 of the overall population in Scotland (Source: http://www.nrscotland.gov.uk/).

buffer area around the statutory boundary of Glasgow in order to avoid any edge effect on the centrality indexes calculated (Figure 30).

Even though pedestrian traffic flows are at the centre of the research, motorways and high-speed thoroughfares are included in the model because such corridors play a fundamental role in shaping the built environment of the city independently of what kind of traffic they are assigned to. It is worth highlighting that MCA is not a traffic study but an assessment of centrality indexes on the urban network, which is defined by existing thoroughfares, including motorways.

It is fundamental to link the analysis of the spatial system to people's experience of the

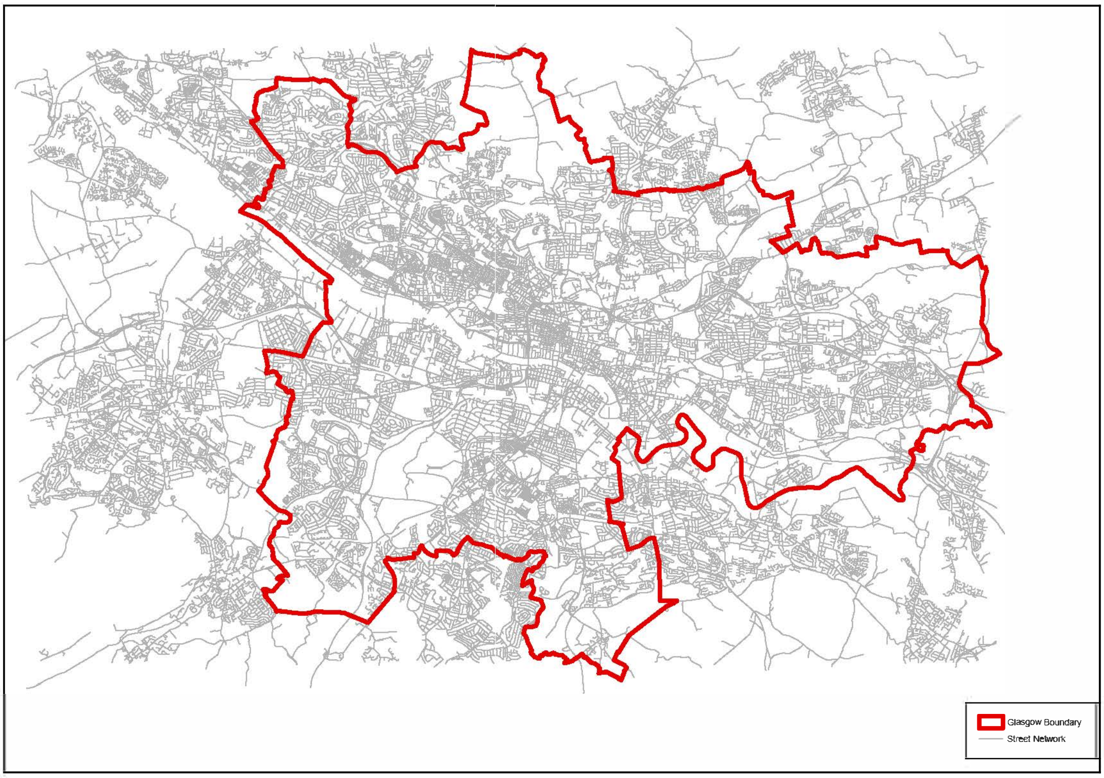


Figure 30. Glasgow's boundaries and the street network used in the MCA calculations. The street network extends well beyond Glasgow's boundary in order to avoid edge effects in the calculations.

built environment. This requires a combination of analysis that includes the properties of the spatial systems as well as where people or facilities are located. Public space is then where all the potential relations between people, or between people and facilities occur in reality.

Such approach results in the analysis of the outcomes of the combination of the spatial factor though its configuration and the content factor – where people, service s or other facilities are located.

Of course, in order to be able to carry out such combined analysis, further information about location of facilities, census outputs, etc. were required and have been provided by Glasgow City Council.

Accessibility of data at the relevant scale of analysis (street or address level) is a difficult obstacle to overcome for researchers. Census data, for example, is aggregated at output area, which is a geometry far too big to be compared to MCA outputs. Also, like most institutional geometries, output areas do not follow "natural" boundaries that have a meaning on the ground, in the real city, in terms of physical barriers or perceived neighbourhood boundaries.

The same can be said for the Scottish Index of Multiple Deprivation whose geometry is far too coarse to be included in our analysis. Such scale issues will be discussed in greater depth in the case studies.

Due to privacy issues the datasets that the municipality was able to release at the right scale were not very many, but included location of commercial activities, rateable values of commercial units, locations of bus stops, train stations, school locations, hospital, gp surgeries, post offices and other essential urban life facilities.

5.3.4. *Maps*

University of Strathclyde and Glasgow City Council both hold licences to OS maps and ArcGIS, therefore base maps with street networks, centre lines, buildings were readily available as a base to this research.

Postcodes geometries and centroids have also been made available, as much data is mapped according to postcode geometry (Figure 33).

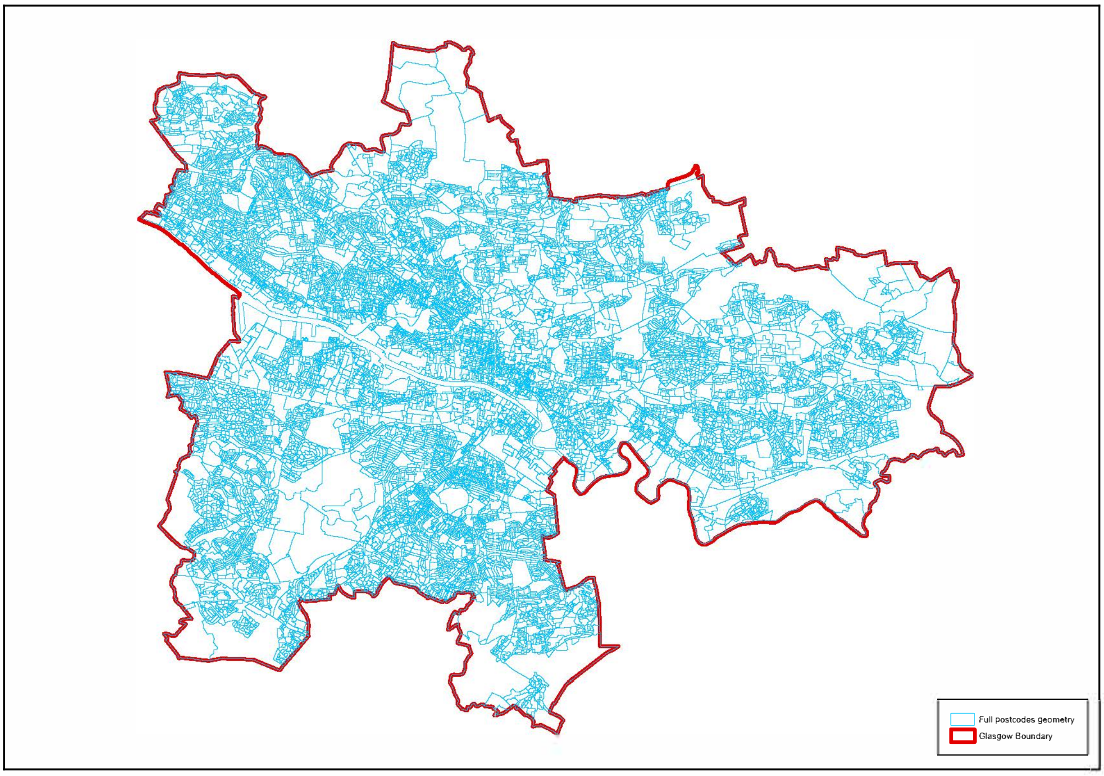


Figure 31. Postcodes units polygons within Glasgow's boundary. There are 14212 polygons of different areas within the boundary; the polygons were defined by Royal Mail and designate an area with a number of addresses or a single major delivery point.

5.3.5. *Computer Tools*

The Multiple Centrality analysis is calculated with the MCA tool, which in the case of this thesis is used together with ArcInfo 10.

The MCA tool has undergone many upgrades since the beginning of this thesis. It started as a toolbox for ArcGIS 9.1, it evolved into a set of Python scripts which worked through and extremely laborious set of steps and had to be run remotely on Strathclyde University's HPC1 computer due to the need of massive computational power, and finally evolved into its streamline final version which runs on Oracle VM VirtualBox.

Results from the MCA tool have been mapped in ArcGIS 10 mainly because of the author's familiarity acquired through a long-term use of the software; the ethos behind the newest MCA tool would in fact support the adoption of Open Source software, and QGIS is the software paired to it. QGIS works very well, in my experience, to carry out simple mapping but when it comes to spatial analysis ArcGIS offers a much more straightforward interface, although I would like to stress again that my judgement could be clouded by the familiarity I have with ArcGIS.

Statistic computations were carried out on Minitab; the software is provided by University of Strathclyde and support was afforded by the department of Mathematics and Statistics at University of Strathclyde.

5.3.6. The urban development of Glasgow

A brief outline of the evolution of the urban environment in Glasgow is given to provide an overview of how the city has reached today's landscape, through different driving forces, the birth and death of industrialization and significant changes in population density.

Glasgow's first settlement was located at the intersection of todays of High Street and Trongate; in 1136 the Glasgow's Cathedral was consecrated on the banks of the Molendinar (Figure 32), event that formalized the birth of the city.

The small nucleus which consequently developed along a North- South axis (High Street) and a West-East axis (Trongate) was surrounded by burghs, whose growth eventually resulted in what today is the city of Glasgow (Frey, 2003) (Figure 33).

Glasgow's real expansion only initiated at the beginning of the 1700 when the trade with the colonies brought substantial wealth and population to the city; wealth which was incremented further with the industrial revolution when the city increased in form and population density in a very short period of time.

The original Burghs, or Town Centres, are still very legible in today's' Glasgow and have been recognized a formal status by the City Plan 2 which ranks them according to their economic capacity.

Glasgow's present urban structure had been framed by 1880 through the interaction

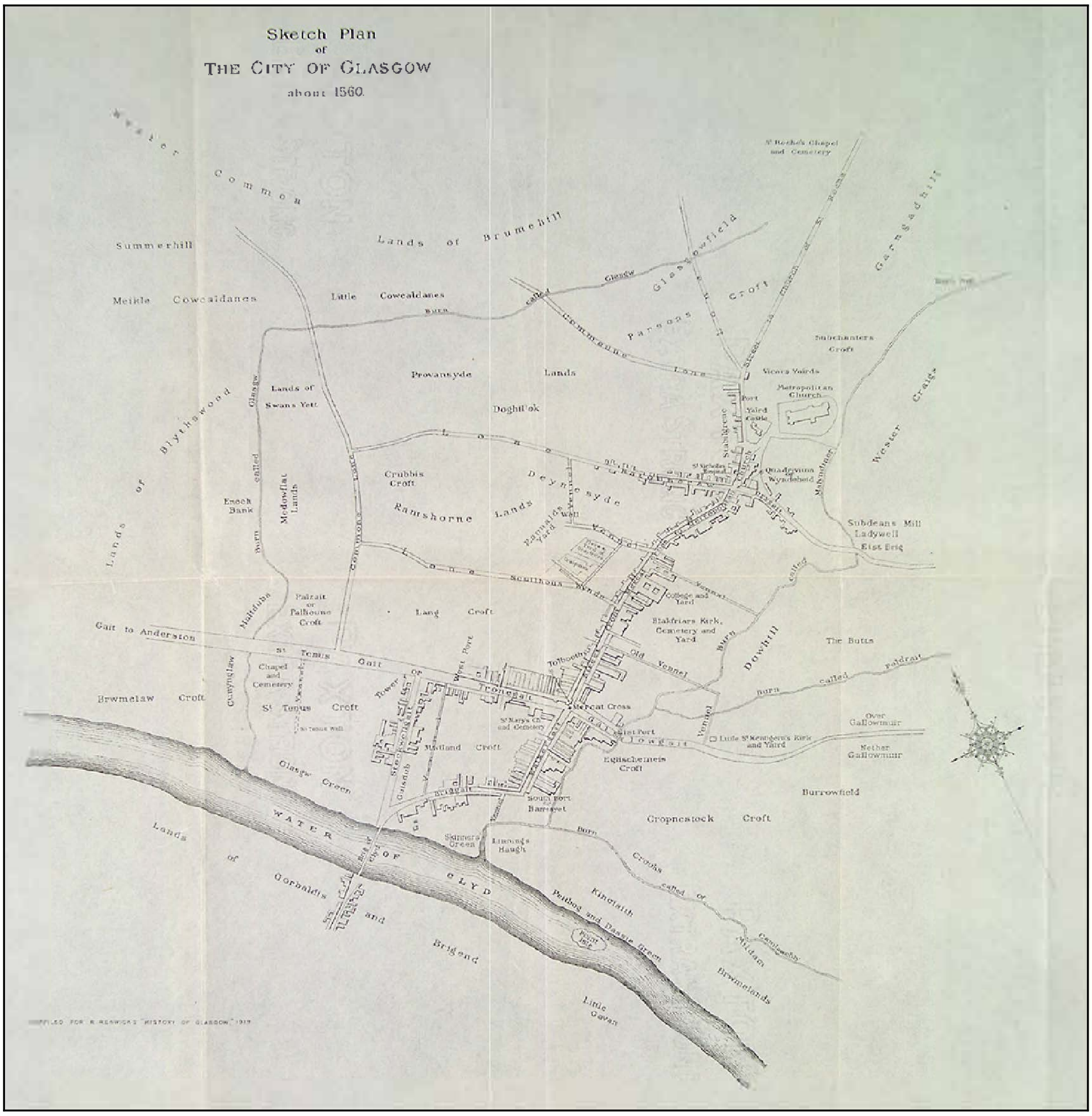


Figure 32. Sketch plan of the City of Glasgow about 1560"published in Robert Renwick's History of Glasgow published in 1919. It appears to have been based on the 1547 map, which was produced in 1894 to illustrate the book edited by Renwick, Protocols of the Town Clerks of Glasgow.(Source: http://www.theglasgowstory.com)

of three main land uses: industry, working class housing and middle class housing (Checkland, 1964).

By 1914 70.000 people lived in the three square miles of Glasgow Cross, which at the time was the most densely populated area in Europe (Pacione, 1979).

The City Corporation through the Housing act of 1919, 1923 and 1924 addressed the shortage of housing through a program of subsidization; until then the provision

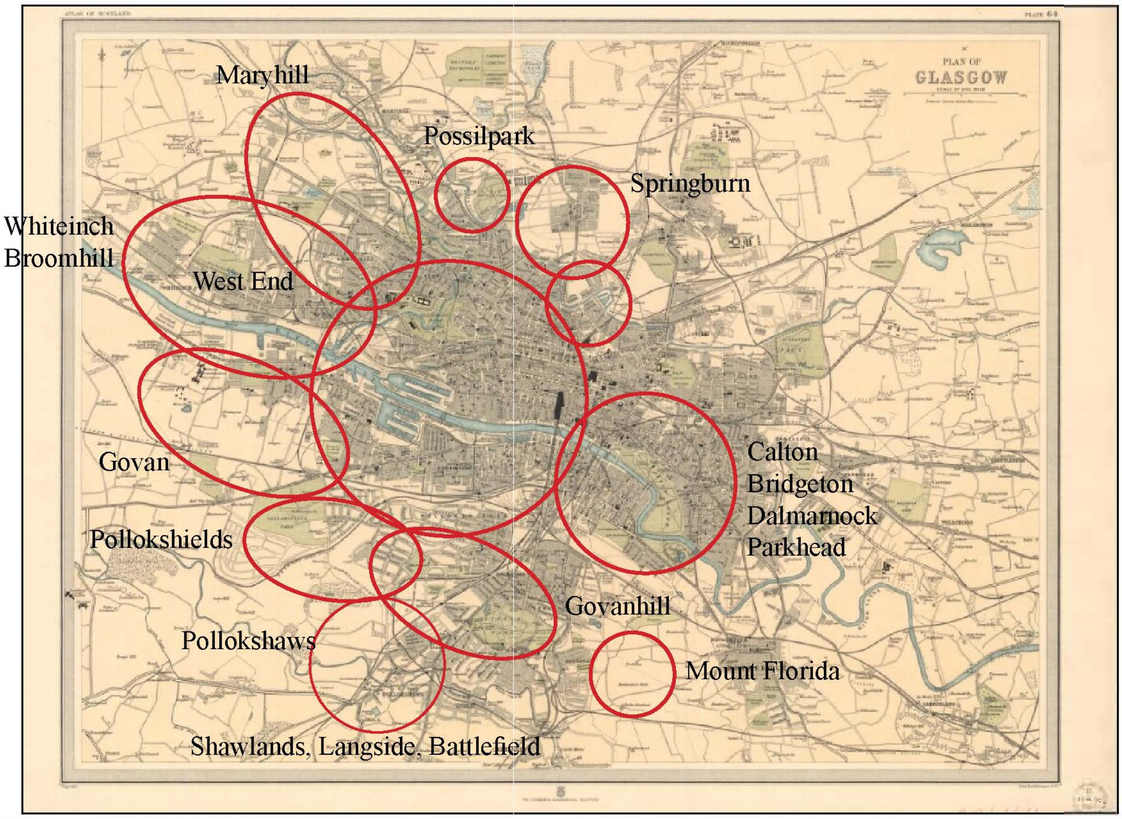


Figure 33. Ordinance Survey Map of Glasgow 1915/16 with the indication of the major Town Centres and their expansion. The map is based on the original image in (Frey, 2003) on page 123; the background image of the original map from 1915 could not be retrieved and the 1912 - BARTHOLOMEW - Plan of Glasgow, from the Survey Atlas of Scotland was used instead. (source:http://maps.nls.uk/towns/#glasgow National Library of Scotland)

of houses had been exclusively regulated by the private sector and the provision for houses for people on low income had been in reality non existent.

After the Second World War Glasgow faced another major housing shortage crisis; furthermore the existing stock of run down tenements offered unsanitary living conditions. A high rise approach was eventually adopted, inspired by the new tower blocks designed by Le Corbusier, through the desire of delivering high densities by the way of new economies of scale and modern technological solutions (Jacobs, 1961), together with the intention of relocating a substantial portion of the inner city population into new towns.

The old stone tenements which framed the streets of Glasgow in regular blocks came down and up went the tower blocks of the Gorbals, Drumchapel, Easterhouse, and Castlemilk (Pacione, 2004), as well as new town overspill developments like East Kilbride (1947), Cumbernauld (1950), and Livingston (1967) (Checkland, 1964a).

After the 1980s the trend reverted to low rise housing developments, some of the tower blocks were demolished (and still are being demolished) or refurbished (Pacione, 1979), and construction in the outer belt towns has continued encouraged by improved communication routes (Lever, 1991).

The Scottish Government policies Designing Places and Designing Streets published in 2010 mark a change of direction in the approach to the construction of new living environments, where design is recognized to have a fundamental role in the delivery of sustainable communities, where a multidisciplinary approach is fundamental, and the public and private sector alike are asked to take responsibility for the design quality of the developments delivered.

Urban design and urban design solutions are at the centre of the vision defined by the above policies but urban form, and in particular the influence of space distribution on social outcomes is still to be included in the discussion.

More recently Scottish Government (SG) is developing a new project, Place Standard aimed at the creation of a series of tools able to assist the design of new hosing developments, which should be inclusive, promote better health, encourage active travelling, foster community engagement and sense of belonging, etc.

What is important is the further recognition by SG that designing new places involves a multitude of layers of information that do not relate uniquely to the built environment, but that the built environment has be able to foster and support.

Glasgow will host the first case study in the development of the tool, possibly in the area of Sauchiehall Districts (as defined by newly adopted City Centre Strategy).

One of the aims of this thesis is to prove how analysing space configuration to support the development of new planning policies could help improve social outcomes of new designed area as well as in project of urban regeneration.

5.4. Multiple Centrality Assessment

5.4.1. Distribution of centrality indexes on the urban network

The analysis of the distribution of centrality indexes in the urban network of Glasgow has been developed through the Multiple Centrality Analysis (MCA).

Centrality indexes indicate how central a place is in respect of the overall urban network, and, depending on the index being examines, how accessible this place is, how likely is this place to be accessed by passing traffic, or how effectively this place can be reached from its surroundings (the literature review on MCA in section "4.2. Multiple Centrality Assessment (MCA)" on page 142 contains further information on centrality indexes).

This section will investigate how Centrality indexes correlate with different aspects of urban policies and Quality of Life.

Centrality indexes will be analysed in relation to positive factors associated with good Quality of Life, such as high presence of commerce and thriving of High Streets, but also in relation to indicators associated with poor social outcomes, such as methadone prescription and within areas indicated as deprived by the Scottish Index of Multiple Deprivation.

Within the existing literature on MCA, areas of the urban network that present high levels of centrality have been found to correlate to high densities of retail and services

(Porta et al., 2007), (Porta et al., 2009), to transit demand (AmilaJayasinghe, 2014) and to urban vitality (Selezneva, 2011).

Although centrality indexes are quantitative, qualitative aspects of the built environment will also be taken into consideration, to support the analytic evidence produced.

The Multiple Centrality analysis is carried out to investigate the overall spatial system of the city of Glasgow but it will also focus on areas of the network that are associated with poor social outcomes (SIMD) and generally present low centrality indexes.

The aim is to confirm that indeed areas with high centrality levels are structurally capable of being economically and socially thriving, but also to underline how urbanized areas of Glasgow which are characterized by post war housing estates, present overall low centrality indexes, both in respect to the whole urban area and within their internal layouts.

The analysis is based on the urban street network of Glasgow and contains both pedestrian and vehicular access roads (Figure 30), as both contribute to the space configuration of the urban environment; in fact the way roads are used can change in time, but streets or roads locations tend to endure in time much longer than other urban elements like buildings or land-uses (Comerio, 1989), (Moudon, 1987).

To capture the relation between the parts and the whole of the urban network three different indexes of centrality are calculated. Betweenness centrality, Closeness centrality at global scale and at 400, 800 and 1600 meters and straightness centrality index.

Global and Local levels coexist in cities; while human beings develop a metric, bodily understanding, of the local level of the built environment – how long will it take me to walk to the shops, to school, the post office, etc. – when having to conceptualize the global level of the city, a process of abstraction has to take over, as distances are too great to be associated with a person's movement (Hillier, 2002).

Global and local translate into two levels of networks, a foreground network formed by the major activity nodes in the city (Figure 34, Figure 35), able to capture the natural movement patterns in the overall structure of the city, and a background network (Figure 36), constituted mainly by residential areas, able to capture the structure – functions relations of everyday life (Hillier et al., 2007).

In the case of centrality indexes, Betweenness Centrality is able to capture the foreground network of urban settlements by exploring the overall structure of the network (Figure 34), while local Closeness Centrality Indexes are able to capture the behaviour of the background network, at a more human scale, which reflects our way of naturally moving or not being able to move on foot around a neighbourhood (Figure 36).

The closeness centrality index is able to capture the background of a city, the local level that as human beings and city dwellers we experience in our day-to-day life.

For urban designers and policy makers, the closeness centrality index is able to

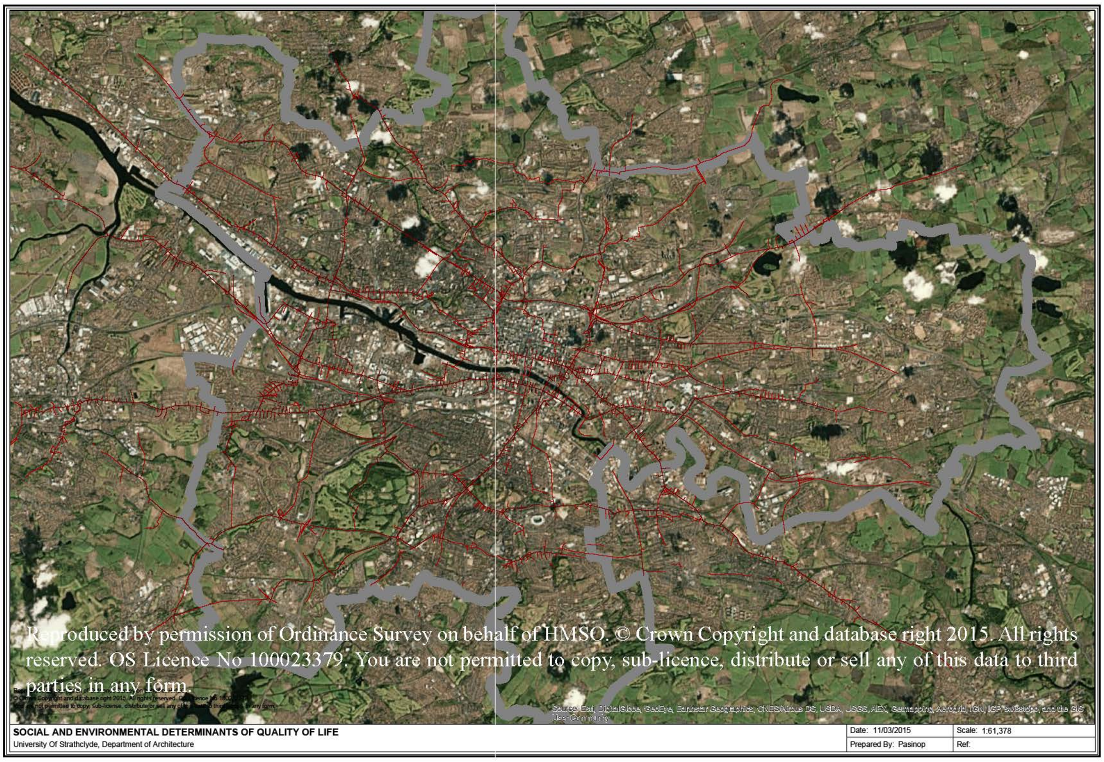


Figure 34. The map above displays the axes in Glasgow's urban network that carry high levels of Betweenness index. As we can see the overall high level transport structure of the city, or foreground network, corresponds to the edges associated with high levels of Betweenness index. (Data source : Glasgow City Council)

Figure 35. This map shows the city centre and beginning of the west end of Glasgow; the axis mapped are only the ones carrying high levels of Betweenness index as in Figure 34 but this scale is more legible. We note that the major thoroughfares, including the M8 (Glasgow's motorway), carry high levels of Betweenness index, confirming again how the index is able to reveal the foreground structure of the city.

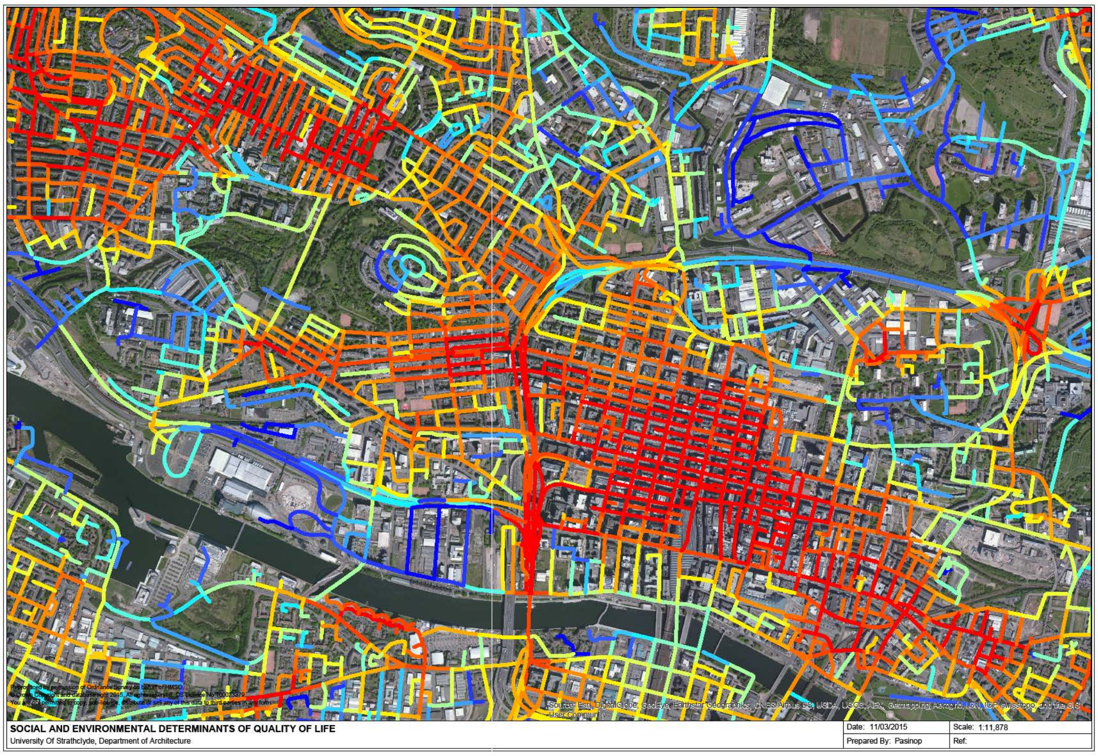


Figure 36. This map displays the variation of the Closeness @400m Centrality Index. We note that the axes that were associated with high levels of Betweenness Centrality in Figure 35 generally have low levels of Closeness @400m as they are not easily navigable on foot. On the other hand areas framed by edges associated with high levels of Betweenness Centrality contain edges associated with high Closeness @400m, as in the case of the city centre. The Closeness @400m index has the ability of highlighting the background of the city, those areas that are easy to navigate on foot and respond to human metrics.

indicate whether a particular area of the city provides good levels of accessibility and permeability; it responds to the basic question, am I designing a place where people and people's movement are the priority or am I designing car dominated environment? The study of the Betweenness index in the previous section provided an indication on how people move between different neighborhoods in Glasgow, but trough the Closeness centrality index, especially calculated at 400m, we will strive to analyze the built environment from a street level or user's perspective.

The overall focus of this thesis is the study of how urban form is able to influence

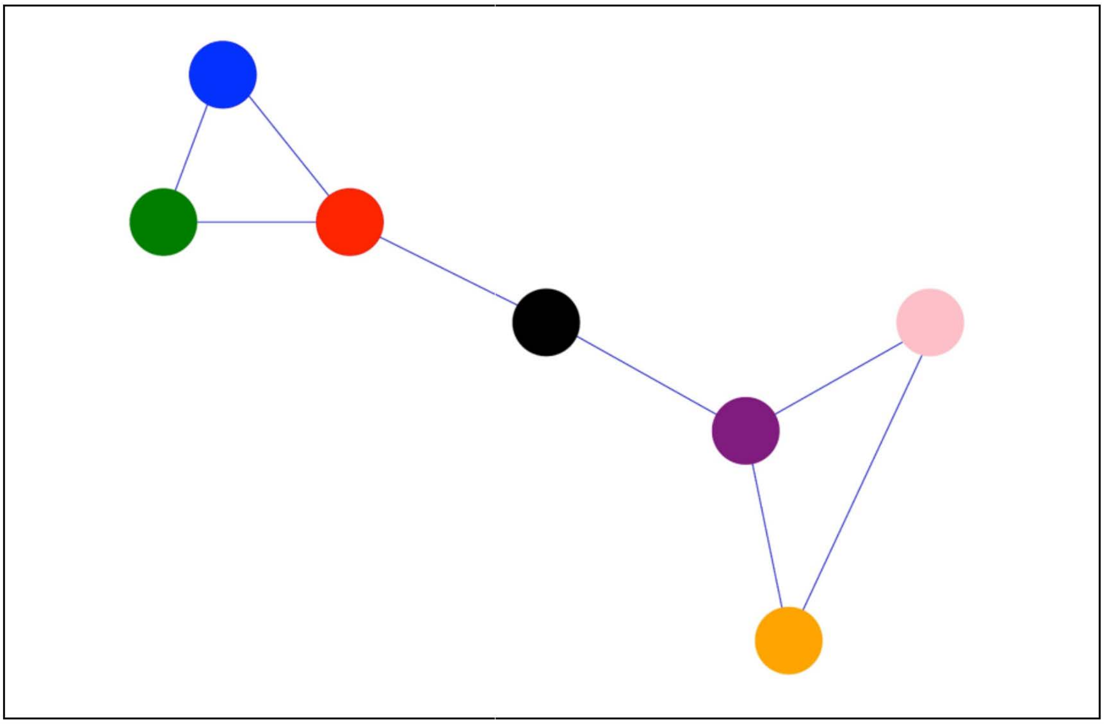


Figure 37. The closeness centrality of a node in a social network is equal to 1 divided by the sum of the distances between that node and all other nodes. Closeness centrality CC measures how close a node is to all the other nodes along the shortest paths of the network (Wang et al., 2011). (Source: http://www.thinglink.com/scene/366327566090371073#tlsite)

people's behavior in space; accessibility analysis are able to capture the potential for people to share public space and day-to-day life activities (Hillier et al., 2005).

The closeness index can be calculated at global level, that is simply how close a node is to all the other nodes along the shortest path of the network, but most importantly, to respond to the above question, it can be calculated at different radii, in the case of this thesis at 400, 800 and 1600m.

The choice of 400m and its multiples as radius values is not casual.

Best known as pedestrian shed, the 400m unit represents an average five minutes walk; it is largely adopted in urban design to indicate a comfortable distance for people to walk to reach their day-to-day activities (Mehaffy et al., 2010).

Through a comparative study of many different cities with diverse historical, geographical, and cultural backgrounds, it has been observed that the main streets in organically developed cities, the ones connecting the global level to the local level, are in the majority of cases 400m or less apart (Mehaffy et al., 2010); this did not happen by design but through human beings naturally developing places that are comfortable to navigate on foot.

The 400m unit emerges as a natural, human scale, measure for the built environment (Mehaffy et al., 2010).

It is also worth considering that not all facilities in a city must or can be reached in a 5 minutes walk; the Urban Task Force diagram in Figure 39 indicates how different facilities in an urban centre serve a different number of inhabitants and therefore have a different catchment radius (Force, 1999).

The diagram illustrates a Local, Neighbourhood, district, Town and City level.

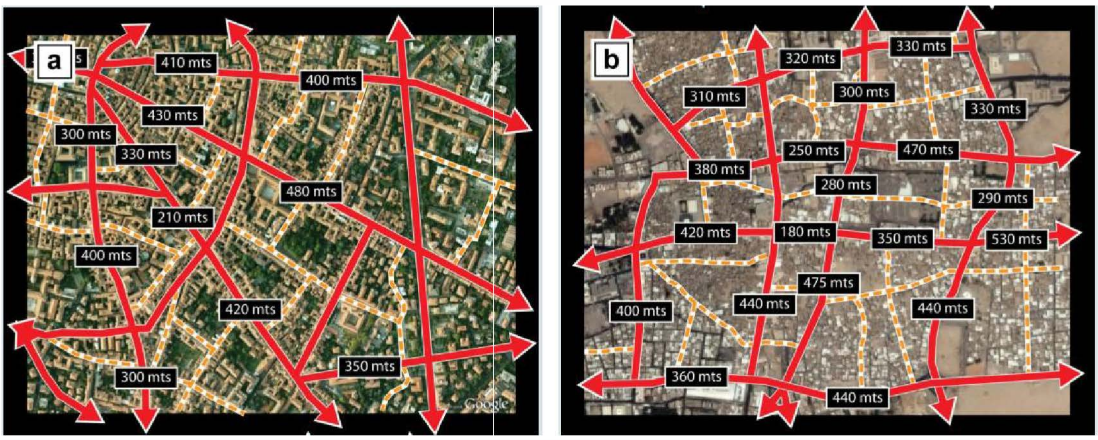


Figure 38. The global level of cities is defined by the main streets indicated in red, while the local level is defined by the secondary streets indicated in orange. In the two cities in the image, Bologna, Italy (plate a), and Al Hofuf, Saudi Arabia (plate b), main streets are about 400m apart (Source: (Mehaffy et al., 2010))

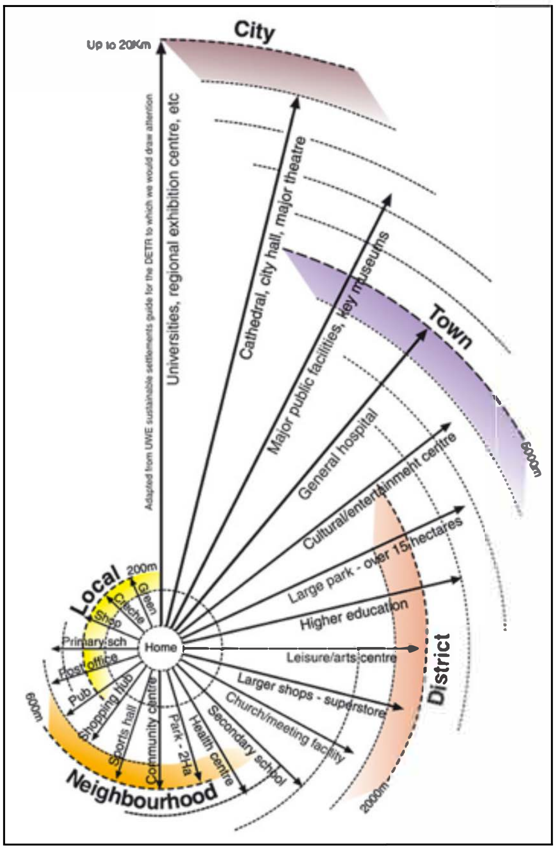


Figure 39. Urban task Force model for ideal facility distances (Rogers Stirk Harbour + Partners); the diagram defines different levels within the city: Local, Neighbourhood, District and Town. Facilities have to be distributed according to their function across all the levels to enable the functioning of a city (Force, 1999).

Through the closeness centrality index we explore the Local (400m), Neighbourhood (800m) and District (1600m) levels, while, as discussed before, the Betweenness centrality index is best suited to analyse the network at Town or City level.

The following sections will explore the findings captured by the analysis of the variation of the Betweenness Centrality index and the Closeness Centrality indexes (Global, @400m, @800m, @1600m) calculated on Glasgow's urban network.

5.4.2. Betweenness Centrality Index in Glasgow's Urban Network

Places that are associated with high levels of Betweenness Centrality are places that are traversed by a higher number of people and whose axis constitute the backbone of the city (Scellato et al., 2006).

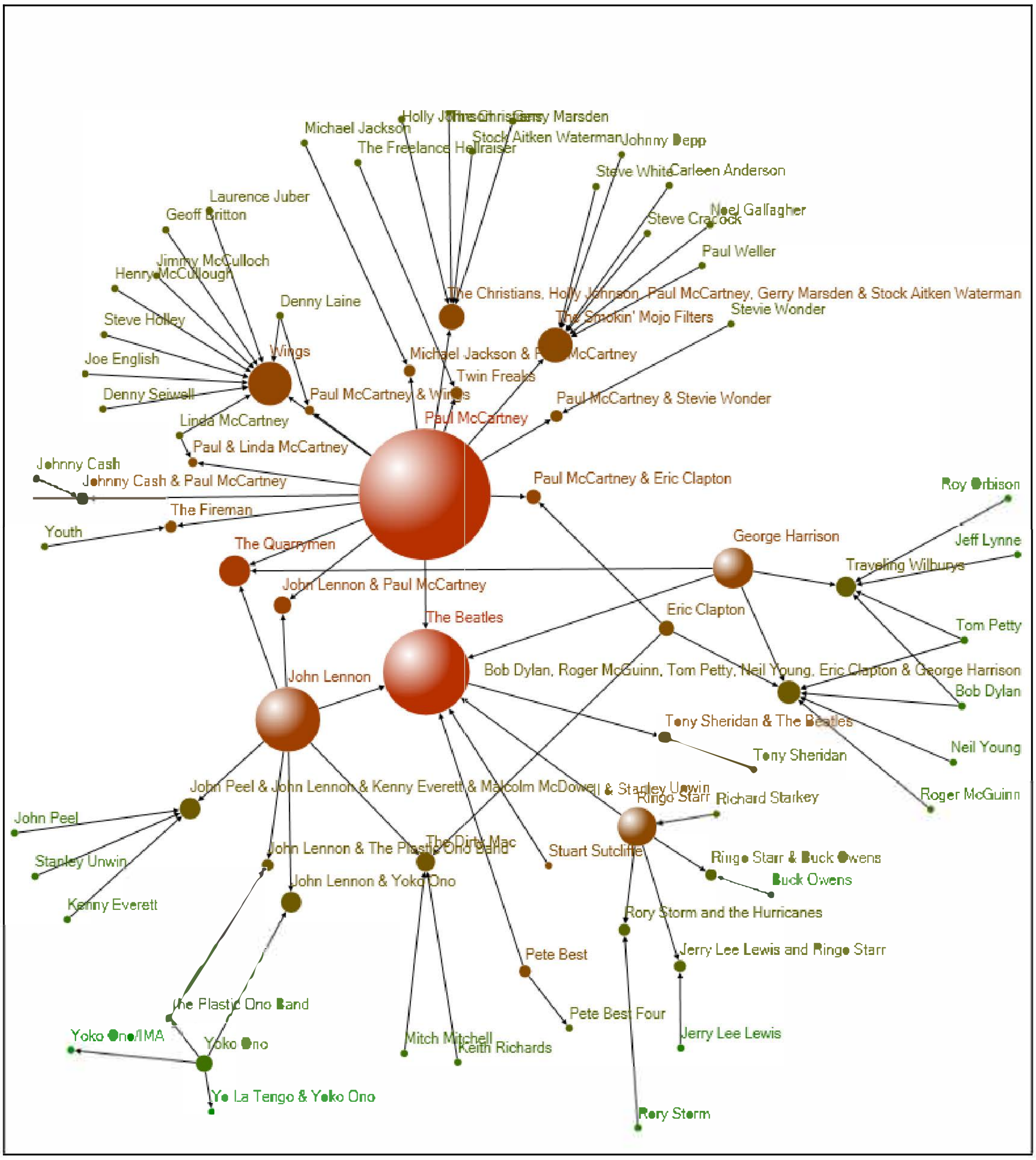


Figure 40. The Betweenness centrality index indicates the likelihood of passing traffic, whether in an urban or social network context. The graph above illustrates musical relationships between the Beatles and other artists. The colour of each node represents its Betweenness centrality. According to this graph, Paul is the busiest member of the Beatles (Source: https://wiki.cs.umd.edu/cmsc734_09/index.php?title=Music_Artist_Collaborations_from_MusicBrainz)

This section will focus on the analysis of the variation of the Betweenness Centrality index across the urban network of Glasgow and on how the desktop study of the index is able to reflect what happens in the real city.

As described in section 5.4.1 the Betweenness Index has the capability of extrapolating the foreground structure of a network by highlighting which are the major arteries at metropolitan scale.

In the map of the highest Betweenness centrality roads along the urban network of Glasgow in Figure 41, the values of the index have been indicated with colours varying from blues to reds, and this is the colour convention we will be applying hereafter to all maps; cold colours relate to low values of the index while warm colours relate to high values of the index (a part from Figure 34 and Figure 35, which only display the axis with the highest levels of Betweenness mapped in red).

Even at a visual examination we can note that the axis with warm colours constitute the foreground structure of the city, that is the axis that allow for long distance movement across the urban network, Glasgow's major thoroughfares departing radially from the city centre, traversing the town centres and reaching in all directions beyond the city's boundaries.

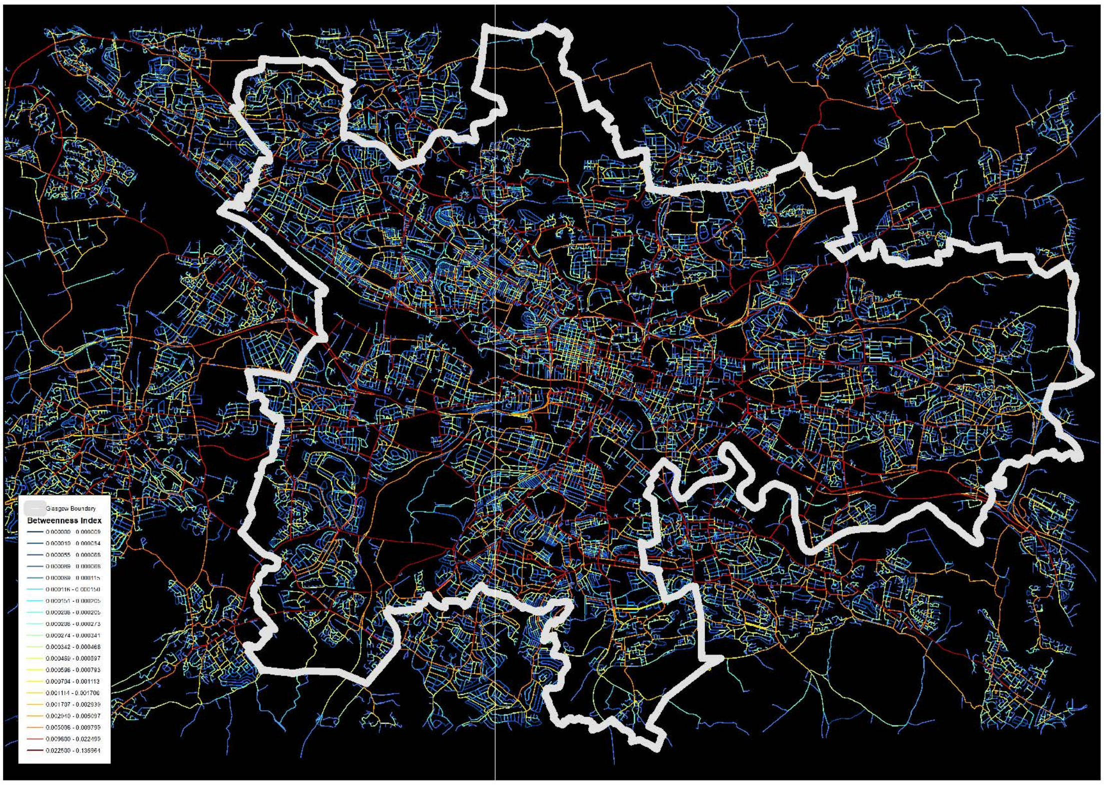


Figure 41. Betweenness Centrality Index calculated over the street network of Glasgow; Warm red colours indicate high levels of Betweenness centrality indexes while cool colours, like greens and blues, indicate low levels of the index, as per the legend in the map.

5.4.3. *Betweenness Centrality and historical development*

The city of Glasgow presents an historical core with an iron grid layout, linked to surrounding smaller activity hubs via major connecting axis, where the iron grid leaves space to a radial configuration.

The axis that present higher Betweenness centrality indexes in the core of the city centre are the ones that traverse the network North to South across the river Clyde and East to West across the motorway (M8) (Figure 43).

A more in depth analysis of the actual values of Betweenness index for each edge highlights how two of the edges with the highest values of centrality in the whole network are the ones located where the first settlement of the city of Glasgow originated, at the intersection between the current High Street and Trongate (Figure 43, Figure 44).

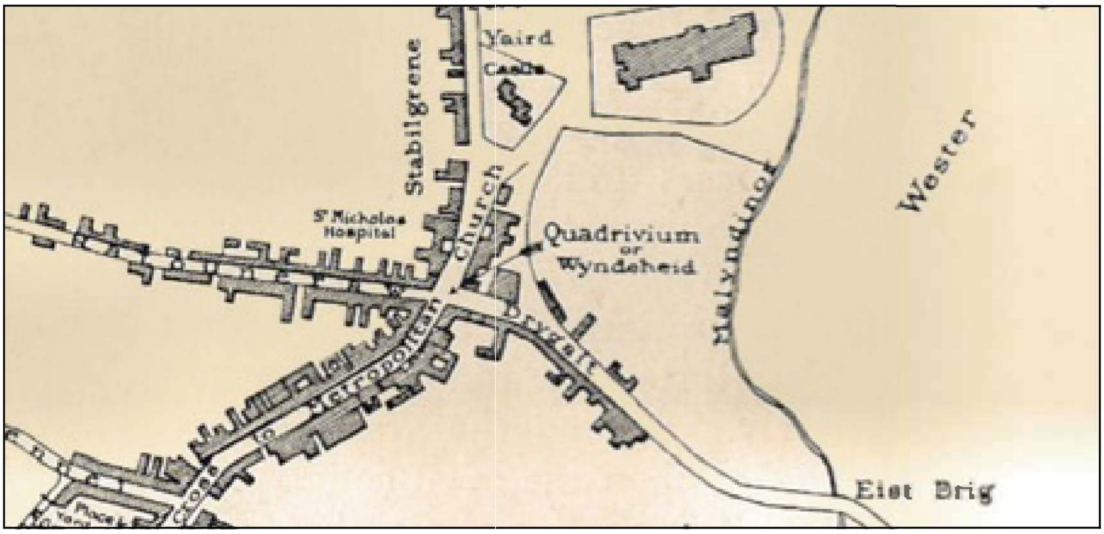


Figure 42. The cartography of Glasgow begins with Timothy Pont's survey in 1596, the Nether Ward of Clydesdale and Barony of Glasgow, published in Blaeu's Atlas in 1564. The map above is a Victorian representation of historical records created by Sir James Marwick (Town Clerk of Glasgow from 1873 to 1903) illustrating the area surrounding Glasgow Cathedral in 1547. Glasgow's oldest house, Provand's Lordship, built in 1471 is situated close to the Cathedral, on the west side of Castle Street. The contemporary High Street is indicated on the map as Street from Mercat Cross to Metropolitan Church and the secular part of the settlement develops around Mercat Cross, the present day Glasgow Cross (Brown, 1921).

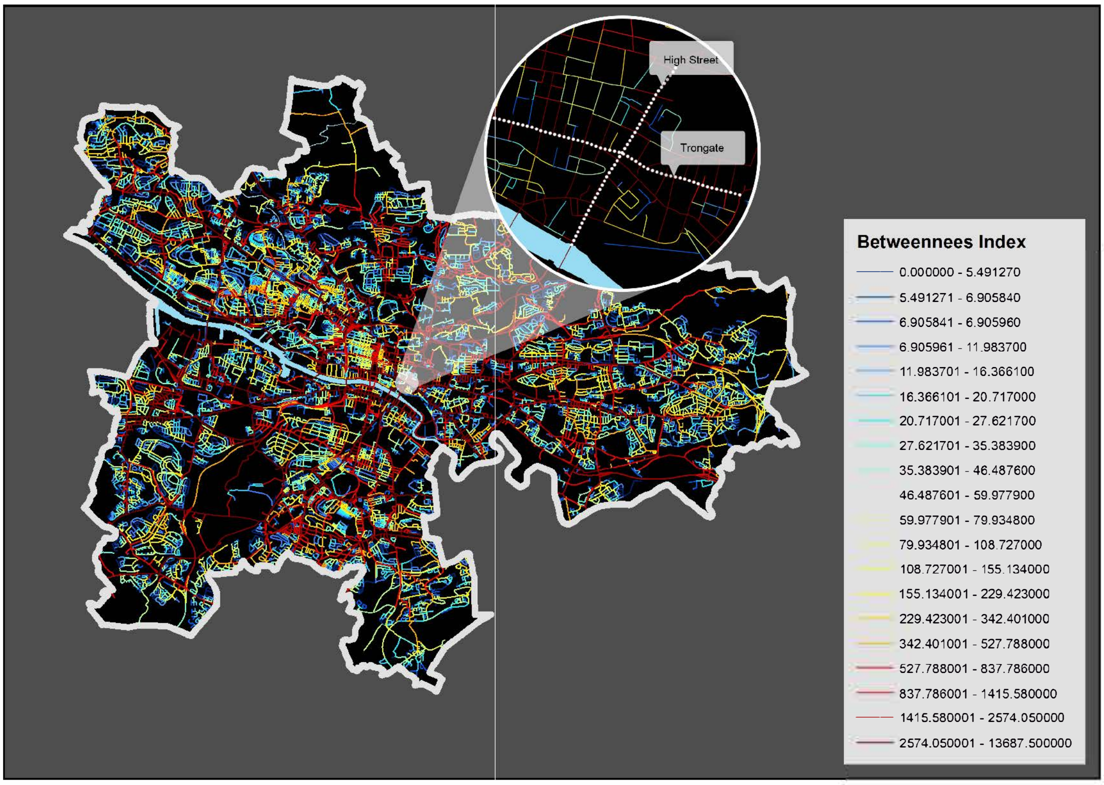


Figure 43. Betweenness index has its highest values along the axis where the city first settlements developed, at the intersection between Trongate and High Street (Glasgow Cross).

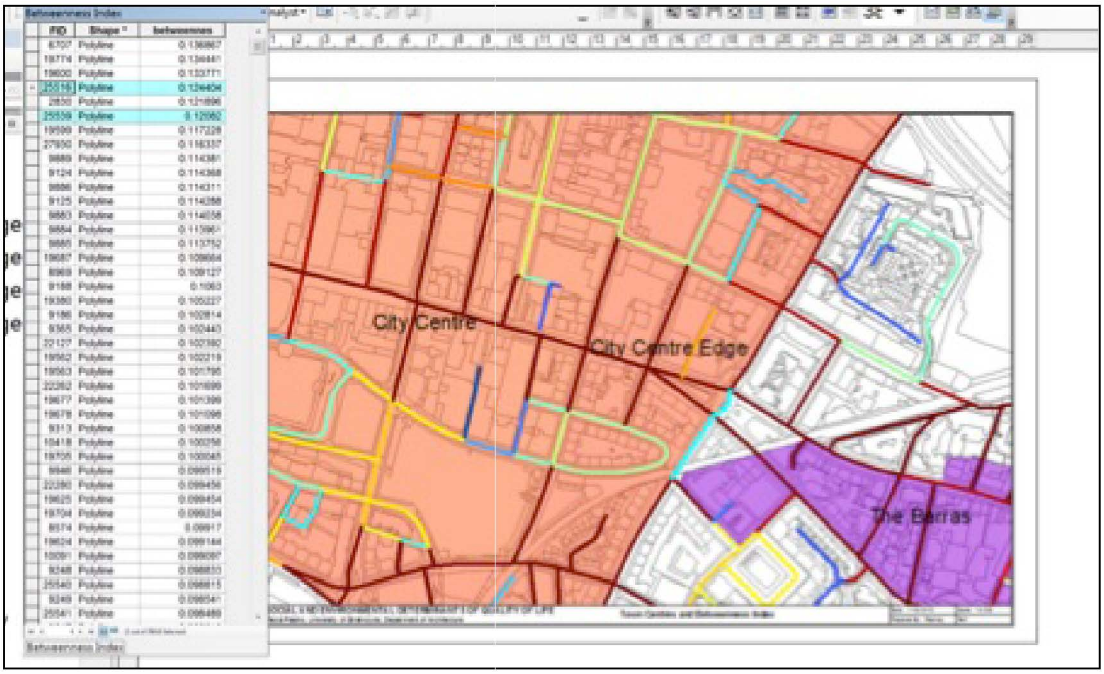


Figure 44. The values of Betweenness index have been sorted by descending order. The forth and sixth edges with highest values of Betweenness are located at the intersection between the High Street and Trongate in the historic nucleus of Glasgow.

Strano, in his paper *Elementary processes governing the evolution of road networks*, reports that the first roads of a settlement retain high levels of Betweenness index even through substantial processes of expansion (Strano et al., 2012).

According to Strano et al., in a process of urbanization, roads which at the birth of the settlement present high levels of Betweenness centrality, will constitute the back bone of the future urban structure, and will retain high levels of Betweenness centrality throughout time.

The argument is supported with the study of the development of the area of Parco delle Groane in Milan across 200 years; in the expansion of and urban settlement is described through two main processes, namely: (i) 'densification', an increase in the local density of roads around existing urban nuclei, and (ii) 'exploration', where new axis connect the existing nuclei to previously not connected areas.

The process described in Milan applies to how Glasgow's urban network evolved according to historical records; the phase of (i)'densification' is carried out by the burghs developing around their main roads, and the phase of (ii) 'exploration' is carried out by the creation of new links between the expanding burghs.

An historical study of how high values of Centrality Indexes remained constant on the main axis connecting the surrounding burghs to the city centre through the full evolution of Glasgow's network is outwith the scope of the this thesis, and it constitutes an interesting point of departure for further research.

5.4.4. *Closeness Centrality Index in Glasgow's Urban Network*

This section illustrates the analysis of the variation of the Closeness Centrality Index calculated on Glasgow's Urban network at the Global level, with a 400m, 800 m and 1600 m radius.

Each radius is able to reveal different aspects of the urban network.

The Closeness Centrality index at global level mapped in Figure 45 presents its highest levels at the core of the city of Glasgow, where the city originated as a hamlet and where today the main commercial and business centre is located. Levels of the index

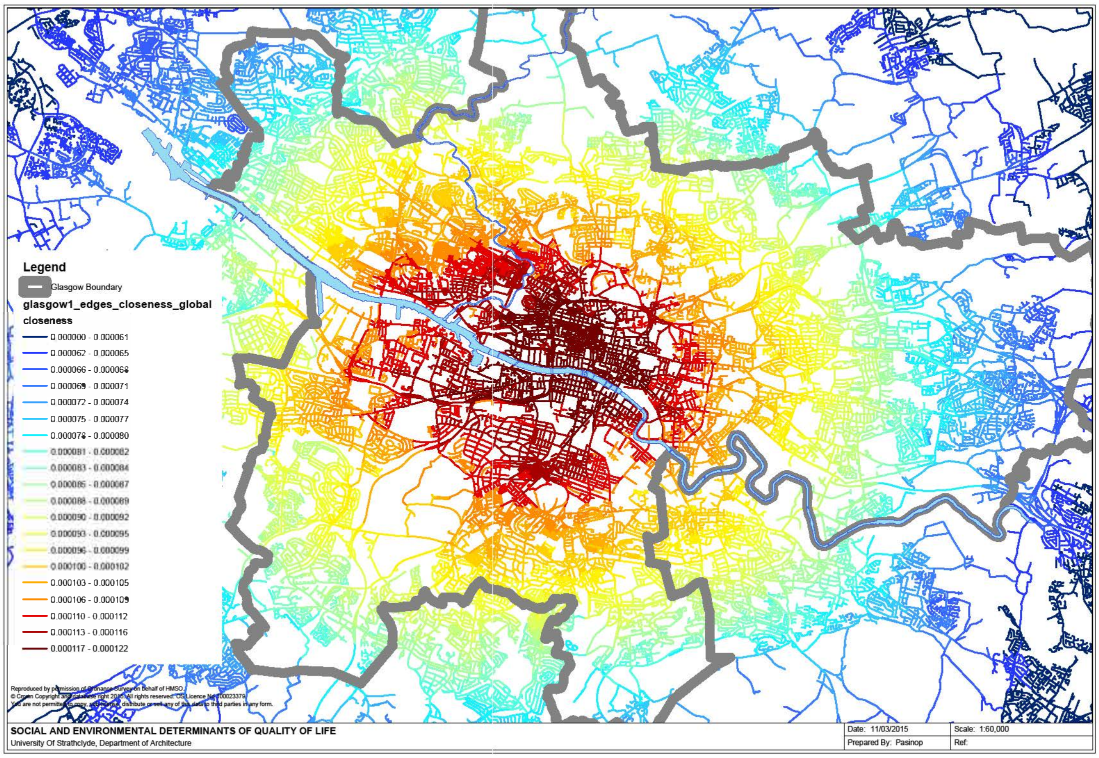


Figure 45. Global Closeness Index calculated over Glasgow's network. The Global Closeness index is able to point to the exact centre of the network, which in case of Glasgow, corresponds with the historical nucleus and contemporary shopping and business area.

decrease as approaching the boundary of the city.

The Closeness Centrality index calculated at 400m mapped in Figure 46 reveals the areas of the city that are easily navigable on foot, moving from point to point with a 5 minutes walk.

The core of the City Centre, as well as some neighbourhoods in the west end and in the south side host the axis with higher levels of this index. It is interesting to note that these areas are not contiguous or connected to one another. The Closeness at 400m is able to highlight the walkable areas within the overall urban network.

As we increase the radius of calculation to 800m the Closeness index reveals areas

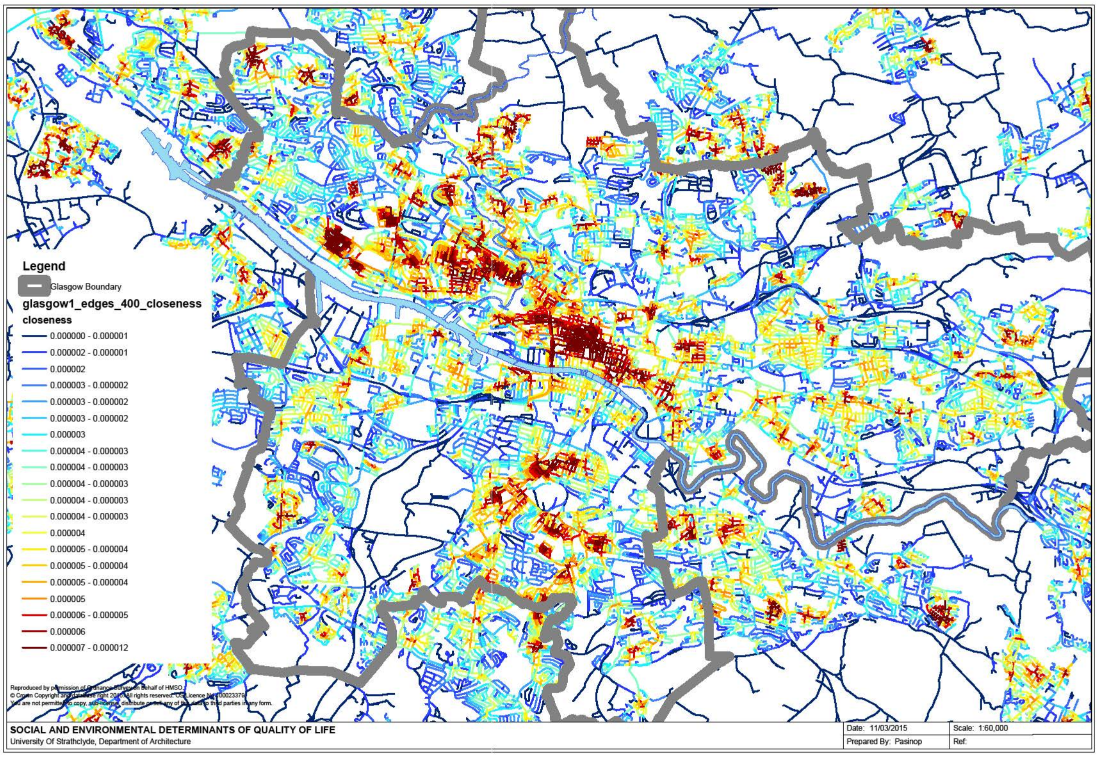


Figure 46. Closeness @400m Centrality Index across the urban network of Glasgow; 400m represent a 5 minutes walk; areas with high levels of Closeness @400m Centrality Index are easily navigable on foot, highly permeable and accessible.

that are still navigable on foot with a longer walk, about ten minutes or so (Figure 47). The areas already highlighted as walkable in Figure 46 by the Closeness @400m are now expanded and the residential west end of the city is now fully connected to the city centre, revealing the existing pattern of pedestrian movement in Glasgow, which mostly occurs from the west to the centre and vice versa. The river Clyde is still a barrier, and the “South Side”, as Glaswegians call the southern area of the city, is still disconnected from the city centre for people moving on foot.

As we increase the radius once more to 1600m the Closeness centrality indexes (Figure 48) shifts its focus to people prepared to walk for considerable length of time, about 20

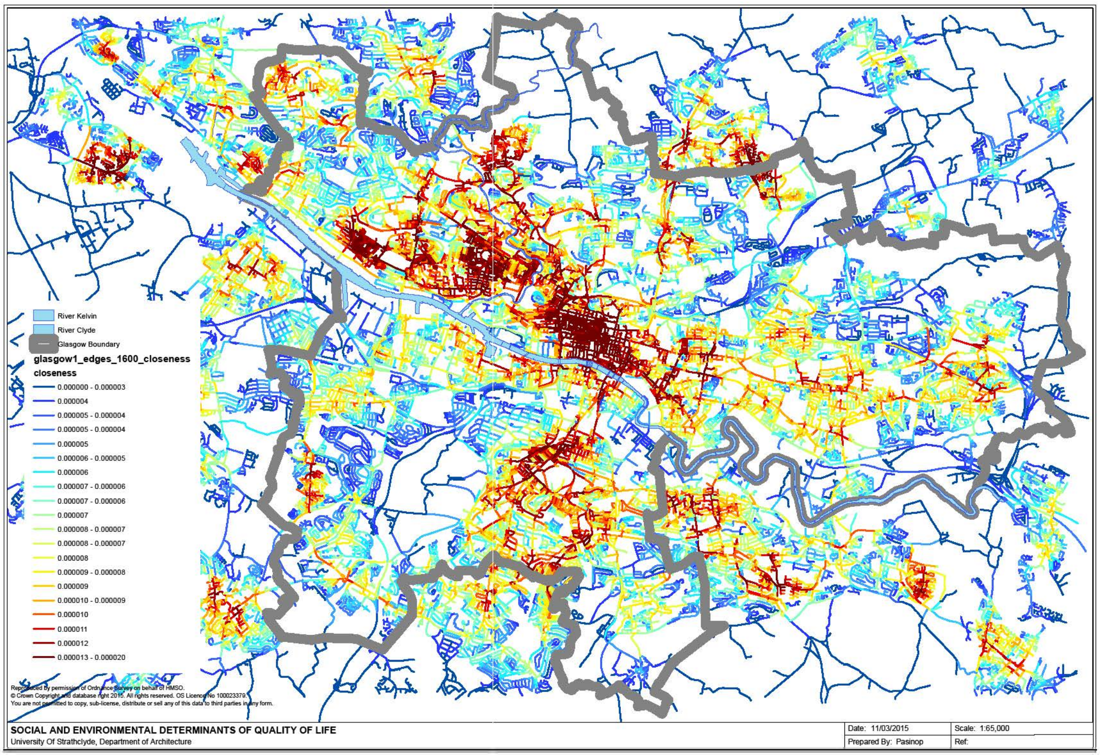


Figure 47. Closeness @800 Centrality Index across the urban network of Glasgow; 800m represent a 10 minutes walk; areas with high levels of Closeness @800m Centrality Index are quite easily navigable on foot.

minutes, or to cycle for a short distance.

In the map in Figure 48 residential neighbourhoods appear connected, from the south side and the north areas of the city boundary, from the west to the east end.

It is interesting to note that Scottish Government and Glasgow City Council are promoting active travel to and from the City Centre; the map of the closeness @1600m is able to highlight which elements of discontinuity in the urban network should be targeted to ensure ease of movement from and to the city centre for active travellers (Figure 48).

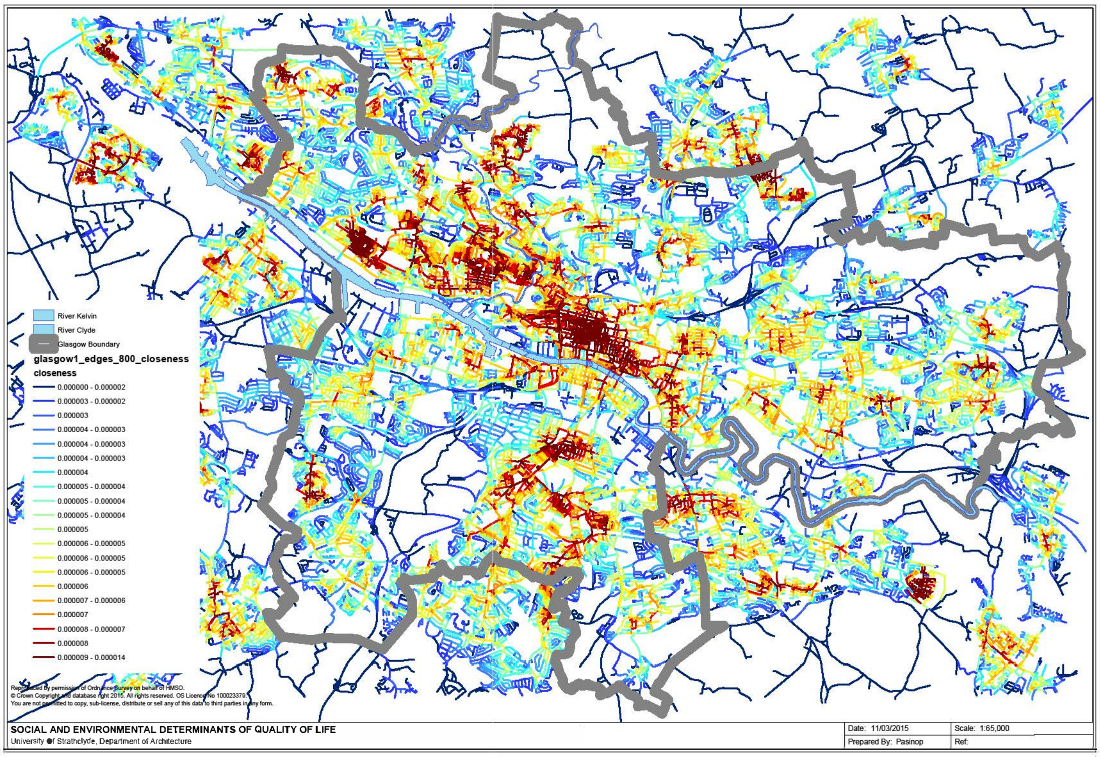


Figure 48. Closeness @1600 Centrality Index across the urban network of Glasgow; 1600m represent a 20 minutes walk; areas with high levels of Closeness @1600m Centrality Index are easily navigable on a bicycle or with public transport.

6. Case Studies and Findings

6.1. Introduction

This chapter analyses the results of the calculations of centrality indexes (Betweenness and Closeness) on Glasgow's urban network through the Multiple Centrality Assessment.

The case studies area based on the detailed analysis of the variation of centrality indexes in Glasgow's Town Centres, Great Western Road - one of the city's historical

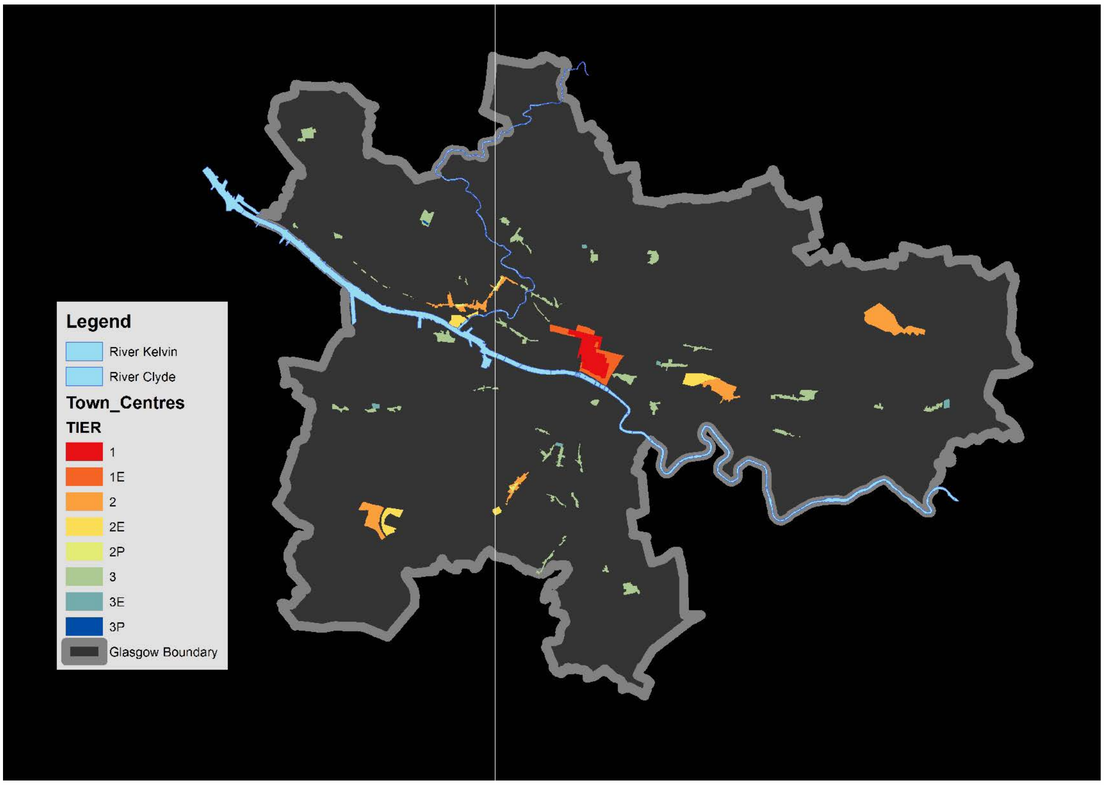


Figure 49. Town Centres in Glasgow as defined in the City Plan 2 (GlasgowCityCouncil, 2009); Town Centres are ranked in the City Plan 2 according to the proportion of ground floor retail use, Tier 1 being the areas where the proportion is higher.

thoroughfares and the three commercial axis of Sauchiehall, Buchanan and Argyle Street, as well as in the peripheral post war housing estates; centrality indexes are also analysed in relation to the distribution of commerce and the variation of rateable values across the urban network.

An analysis of the relationship between centrality indexes and methadone prescriptions is also outlined, but the impossibility of accessing medical data at the right scale prevented a satisfactory outcome of this case study.

6.2. Summary

Planning and transport policies have left substantial scars in the urban fabric of Glasgow. The discontinuities caused by the scars are evident in the foreground and background networks of the city, as highlighted through the analysis of the Betweenness and Closeness centrality indexes.

The analysis of the relationship between centrality indexes and commercial activities, as well as the variation of rateable values, confirms that centrality indexes are higher in areas that present good levels of street vitality.

Case studies also confirm that areas that are particularly disconnected from the overall urban network and offer poor internal connectivity, tend to present overall poor social outcomes as indicated by the SIMD.

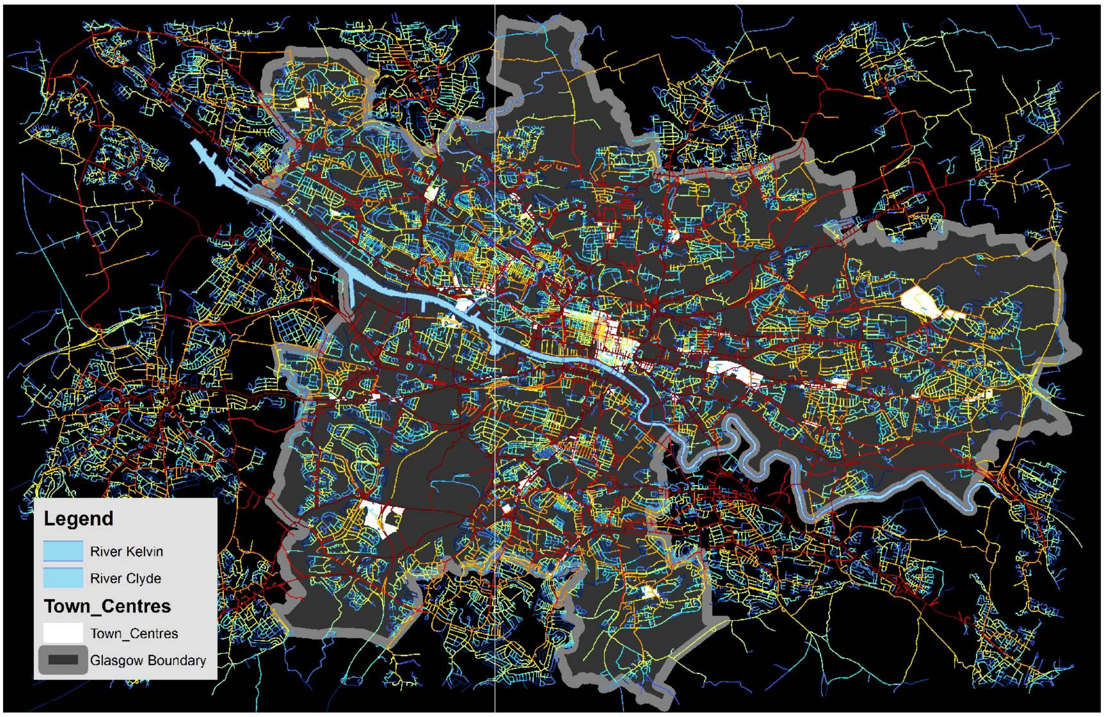


Figure 50. Betweenness Centrality Index mapped over the Town Centres as per City Plan 2. Axes with high levels of Betweenness Centrality traverse the Town Centres (see detailed maps in Appendix 8.1).

6.3. Town Centres and Centrality Indexes

6.3.1. Study area and data Sourcing

Most of Glasgow's historical Burghs are nowadays important activity hubs in the City, at the centre of residential communities; Glasgow's planning framework, and in particular the City Plan 2, defines them as Town Centres and ranks them according to their economic performance (GlasgowCityCouncil, 2009) (Figure 49).

The study area is consistent with the rest of our case studies confined within Glasgow's political boundaries.

Glasgow City Council has provided data on the location, boundaries and economic classification of the Town Centres.

The local authority has also provided the urban network and OS maps.

Each Town Centre, as defined by City Plan 2, has been studied in detail to analyse the behaviour of centrality indexes in relation to each urban hub.

The methodology involves a visual analysis of the variation of the centrality indexes in each Town Centre location; in the case of particularly interesting findings, the visual analysis has been paired with an investigation of the historical development of the Town Centre in object.

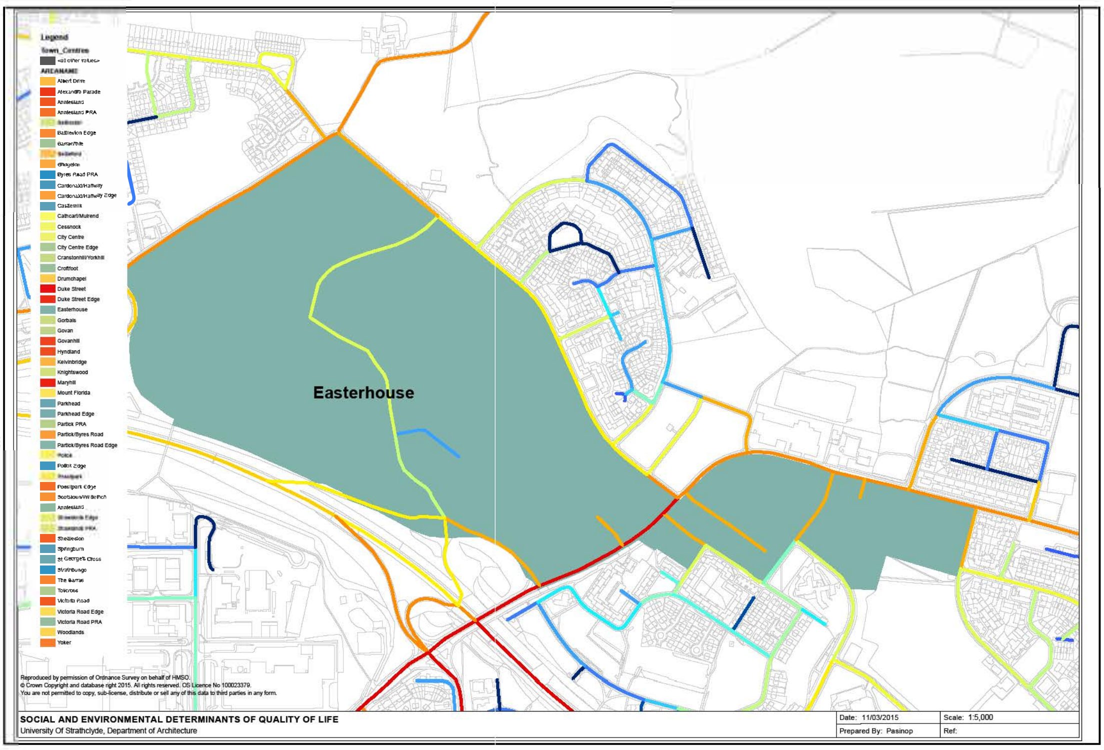


Figure 51. Easterhouse is a post-war development located in the eastern corner of the Glasgow Boundary. Developed by Glasgow Corporation in the 1950s, the vast estate was built to offer better living conditions to the population of Glasgow already living the east end.

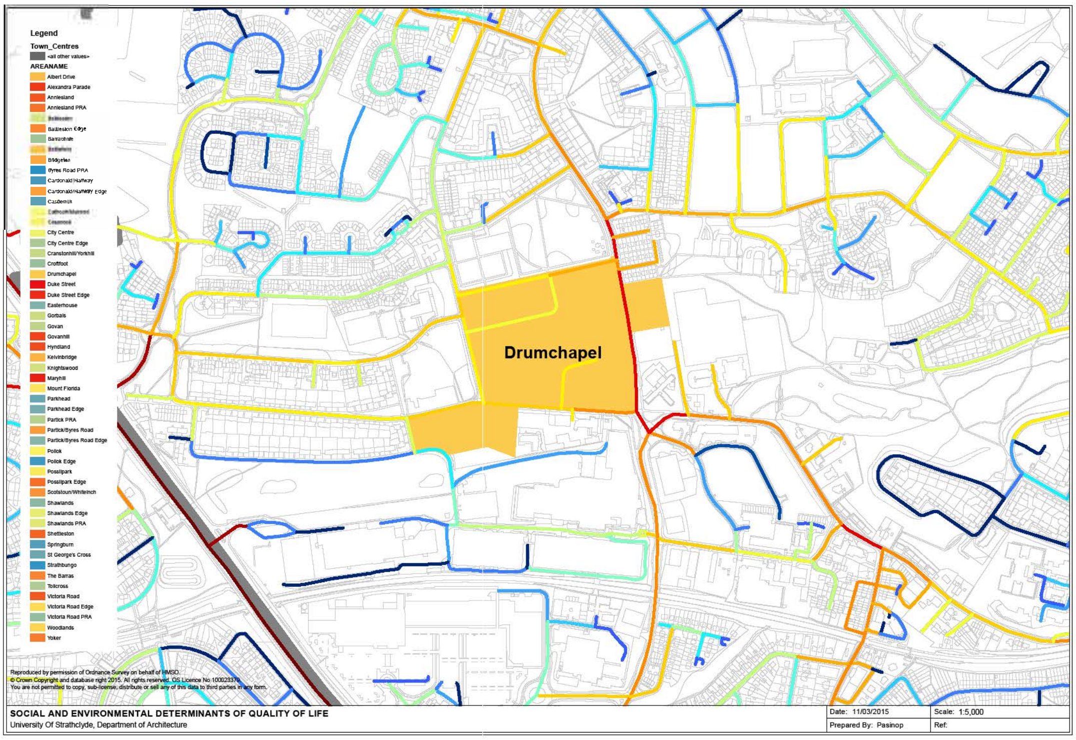


Figure 52. Drumchapel is a post-war development located in the north west corner of the city boundary. Developed by Glasgow Corporation in the 1950s, the vast estate was built to house 34.000 people as part of a programme of clearance of inner city slums.

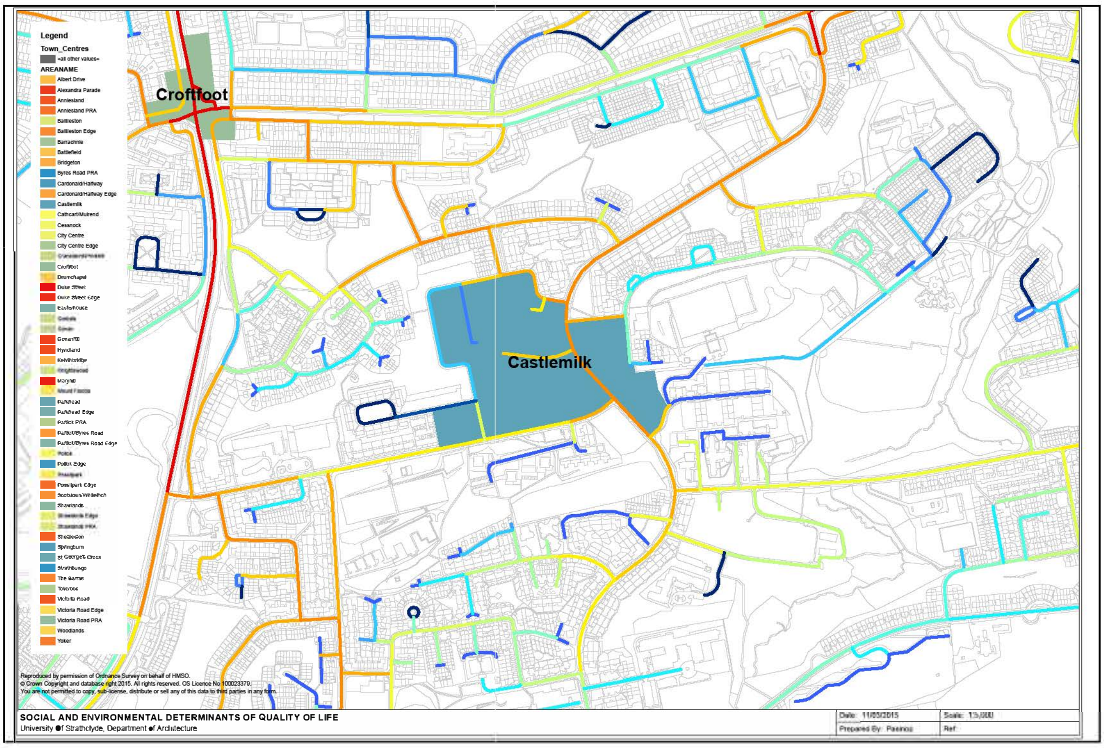


Figure 53. : Castlemilk Town Centre. Castlemilk is a post war development located in the south of the city. The Glasgow Corporation developed this peripheral housing scheme in the 1950s as part of a programme of clearance of inner city slums. Levels of Betweenness index are low in the internal streets of the development and are higher in the axis surrounding the area.

6.3.2. *Town Centres and Betweenness Index*

The two following sections explore each Town Centre in relation to the analysis of the centrality indicators as well as their historical development.

Glasgow's Town Centres are focal points on the urban network traversed by axis presenting high levels of Betweenness as we can see in Figure 50; in the real city, Town Centres are active areas with services, shopping facilities at the heart of the surrounding residential communities.

The variation of levels of Betweenness index at each Town Centre is investigated by a detailed analysis of each town centre. A full set of maps illustrating how the axis (high streets) traversing the Town Centres present high levels of Betweenness is included in Appendix 1: Town Centres and Betweenness Index.

Out of the fifty-eight (58) Town Centres, five (5) do not follow the general trend of being traversed by high centrality axis: Knighstwood, Govan, Drumchapel, Castlemilk and Easterhouse.

Out of the five cases, three (Easterhouse - Figure 51, Drumchapel - Figure 52 and Castlemilk, Figure 53) are post war modernist developments, whose process of urbanisation have not been organic like in the case of the historic burghs, but planned and developed in the 1950s.

The case of post war modernist developments will be explored in further detail in section “6.6. Post war housing developments in Glasgow” on page 278, but it is worth noting that there are other areas of post war developments in Glasgow (a part from Easterhouse, Castlemilk and Drumchapel), such as Maryhill, Pollock and Possilpark (Pacione, 2004a). Such areas are not included in this discussion as their town centres are located in what remains of their historical part.

Govan and Knightswood do not comply with the general trend because of their historical developments and will be examined more closely in Town Centres and Centrality Indexes.

6.3.2.1. Case Study: Govan Town Centre

Govan is one of the oldest burghs in Glasgow, its original settlement dates back to the 7th century; in time Govan expanded greatly and reached its highest number of habitants between the late 19th century and the first half of the 20th century. At the time, Govan was at the centre of the shipbuilding industry, inhabited mainly by lower working class it a very busy and thriving part of the city (Gibb, 1983).

We can observe in Figure 54 that at the moment Govan Town Centre is traversed by a high street with moderately high levels of Betweenness centrality, but definitively not quite as high as the high streets of the other town centres in Glasgow. The river Clyde represent and obvious disconnection from the rest of the network.

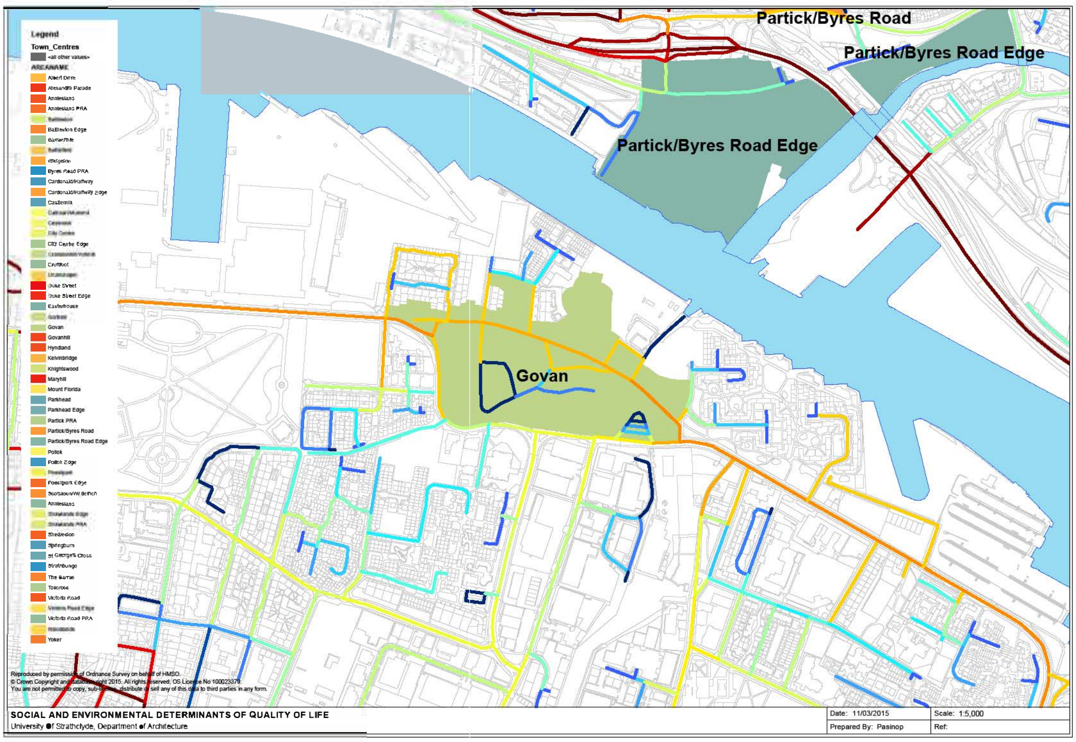


Figure 54. Govan is one of Glasgow's oldest town centres, the original settlement dating back to the 7th century. Govan expanded greatly during the late 19th century and has been traditionally viewed as a lower working class area.

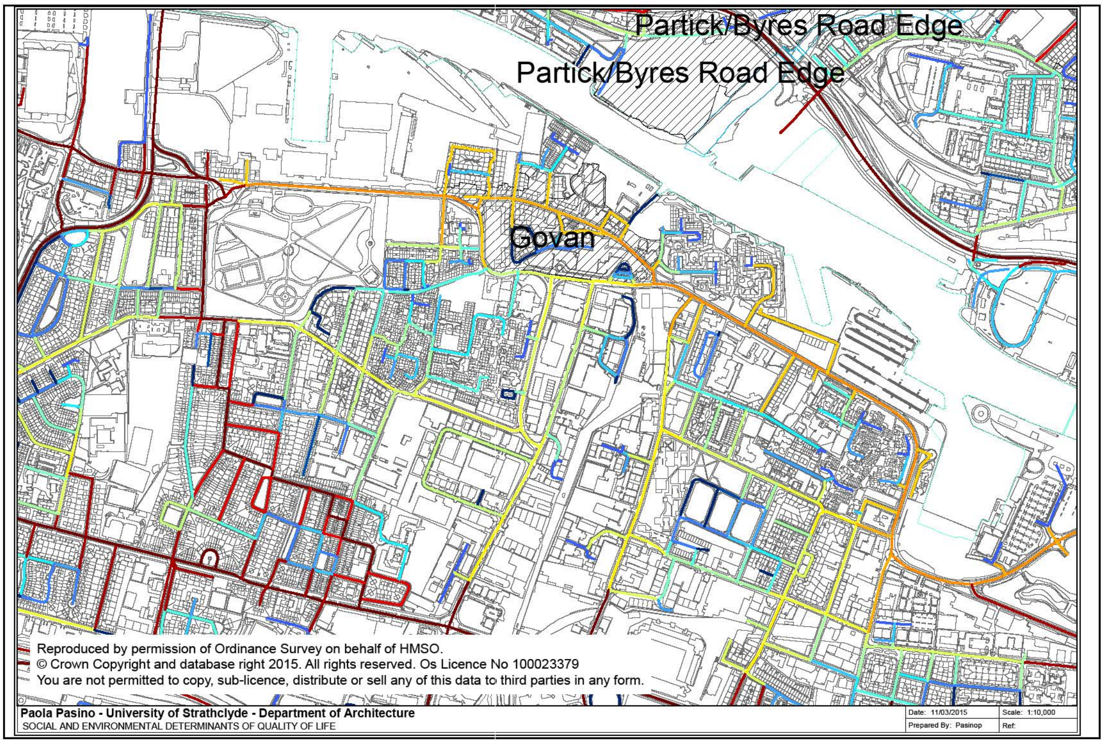


Figure 55. : Govan town centre in scale 1:1000. This map offers a view of the wider context and of how the Betweenness Centrality Index varies in the rest of the surrounding area.

The deepening of the Clyde to improve navigation only started in 1768, but originally the river was a stream with several sandbanks and little islands dotted along its course. The Clyde was particularly shallow at Govan and at that location it was easily traversed (Riddell, 1979).

The location was therefore extremely popular and an early settlement developed thanks to the traffic between the two sides of the river; the importance of the connection between the two banks was still vital several centuries later as testified in the OS maps from the early 1930s, which indicate that 3 ferries were connecting Govan, by then a thriving civic centre, to Partick on the other bank (Figure 56).

In order to investigate if the connections across the water provide by the ferries could

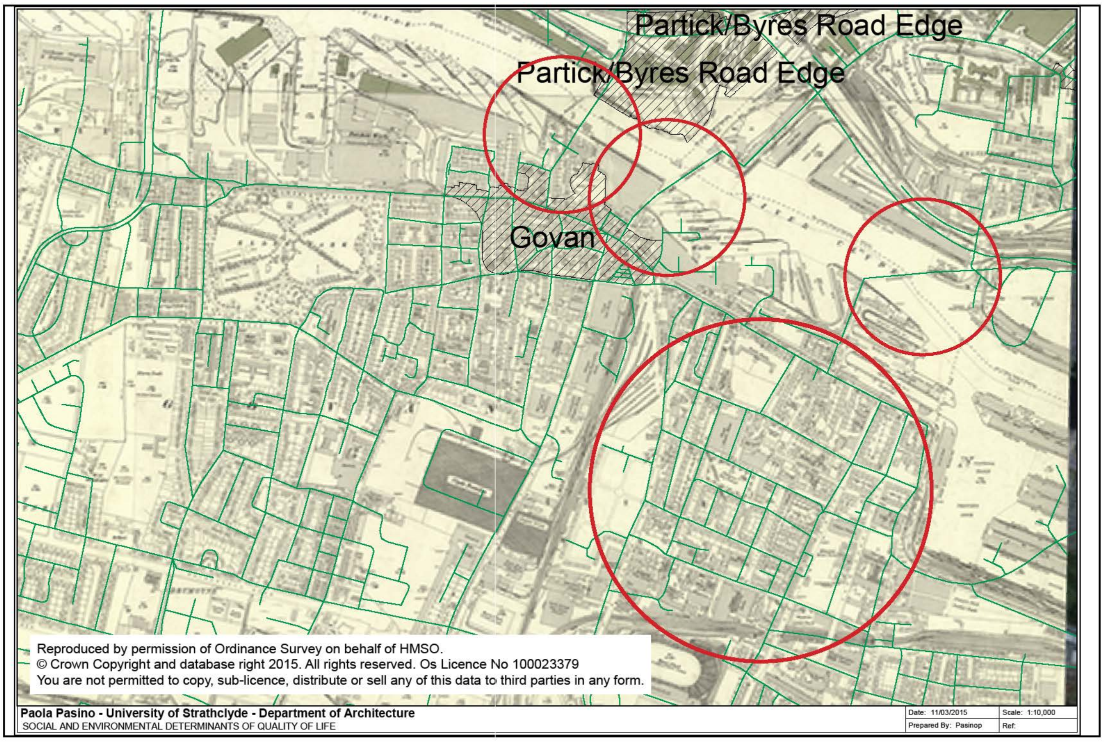


Figure 56. : Historical OS Map of Govan from 1932-1934 (Courtesy of National Library of Scotland).The historical map is overlaid with a modified version of the current street network, where connections across the Clyde have been added at the locations of the Ferries in the 1930s. A few East to West connections have also been added to reflect the historical urban form now lost due to post-war developments. The red circles highlight the new connections.

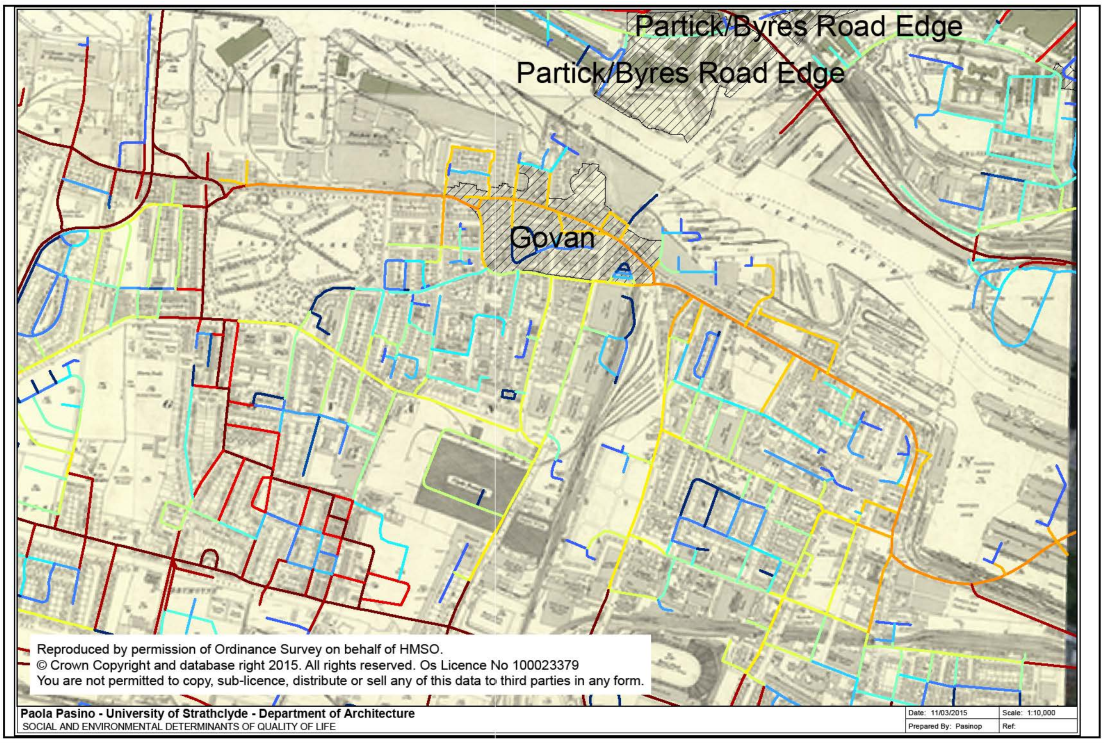


Figure 57. : Historical OS Map of Govan from 1932-1934 (Source: National Library of Scotland). The map depicts Govan at the height of its population density and when it was a very thriving civic centre. The current street network displaying the variation of the Betweenness Index is overlaid on top of the historical map. Although the quality of the historical map is not excellent we can note quite a remarkable difference in the urban form. The residential areas were laid out in regular tenement blocks and access to the other bank of the river was ensured through 3 ferries, one where the Clyde Tunnel is situated toady, and two at either sides of the river Kelvin.

improve Betweenness Centrality in the high street traversing Govan Town Centre, the existing street network has been extended across the water where the ferries used to run, and a few East to West connection have also been re established where the urban form was disconnected by post war developments (Figure 58).

The new connections across the river Clyde and East To West dramatically improve the levels of betweenness centrality in Govan, in the town centre, in the residential areas and naturally along the connections to the North Bank.

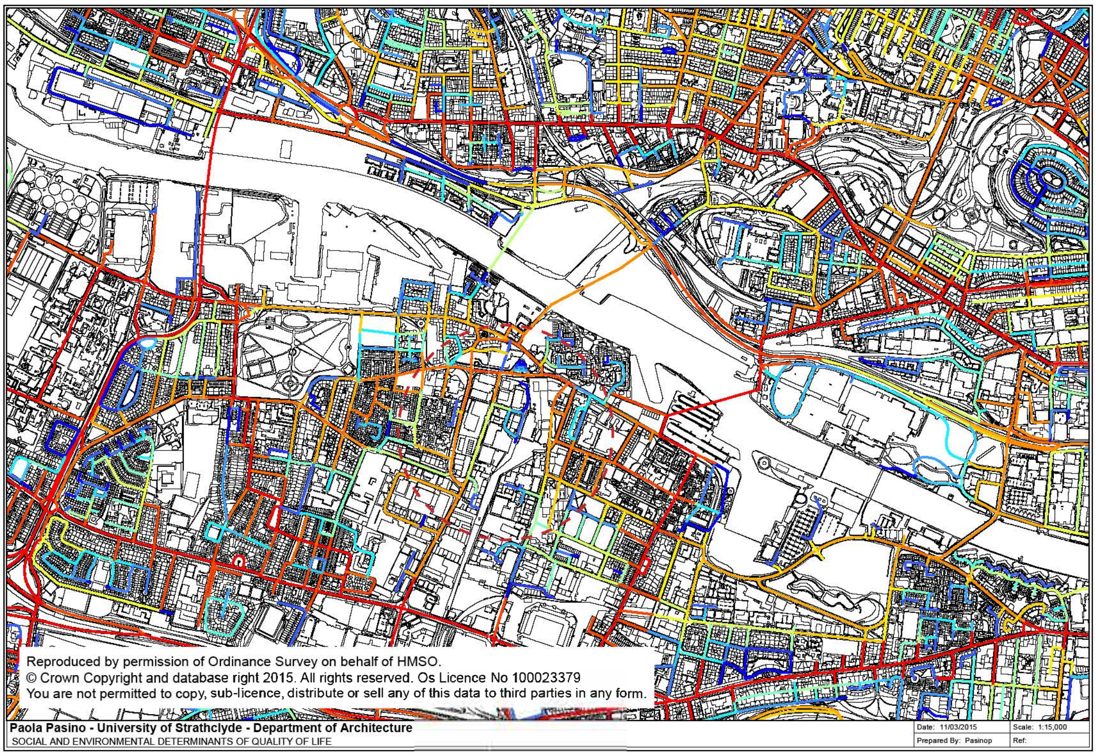


Figure 58. This map displays a new scenario, where Govan is connected to the North Bank of the River Clyde with three new bridges and the area contained in the dashed red circle has been rationalized with the addition of a few east to west connections. Figure 59. Such improvements would improve dramatically the potential for development of Govan Town Centre. Glasgow City Council supports the proposal on introducing at least one pedestrian bridge at the Riverside Museum; the bridge will be implemented as a part of a series of infrastructural improvements funded by the recently awarded City Deal.

6.3.2.2. Case Study: Great Western Road

This case study focuses on Great Western Road, one of Glasgow's main thoroughfares, which traverses two Town Centres, Anniesland and Kelvinbridge. Levels of Betweenness centrality vary greatly along the length of the axis and increase in proximity to both Town Centres.

Great Western Road runs from St Georges Cross, through Kelvinbridge to the north west of the city at Anniesland (Figure 60); the axis continues after Anniesland changing name and connecting Glasgow to Lock Lomond beyond the City's boundary.

Although this axis existed historically to connect Anniesland (one of Glasgow's Burghs) to Glasgow itself, the construction of the modern road started in 1841 to reduce the

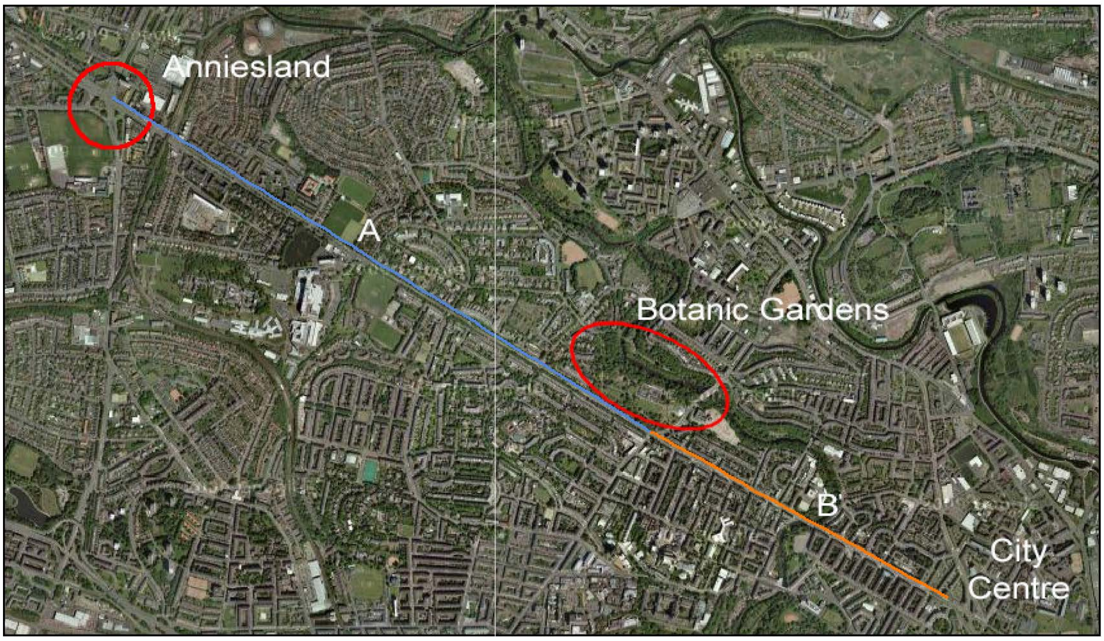


Figure 60. Great Western Road, stretch A between Anniesland and the Botanic Gardens is indicated in blue, Stretch B between the Botanic Gardens and the City Centre is indicated in orange (Bing map in the background)

travel time from the west to the City centre (Gibb, 1983).

The new road was planned to facilitate the development of new modern and upmarket residential areas in the west of the city, where the estates presented "natural assets of altitude, fine outlook, and cleaner air helped by the prevailing westerly breezes" (Glendinning et al., 1996) (Atherton, 1991).

The new road triggered the development of new residential areas from the middle of the 1800s; the estates of Kelvinside and Hillhead, even if very close to each other, present very different development histories and a very different urban form as an outcome (Figure 61).

The Kelvinside estate started to be developed in1840 for the city's upper middle class with Decimus Burton, who had worked with John Nash in London, as the estate's

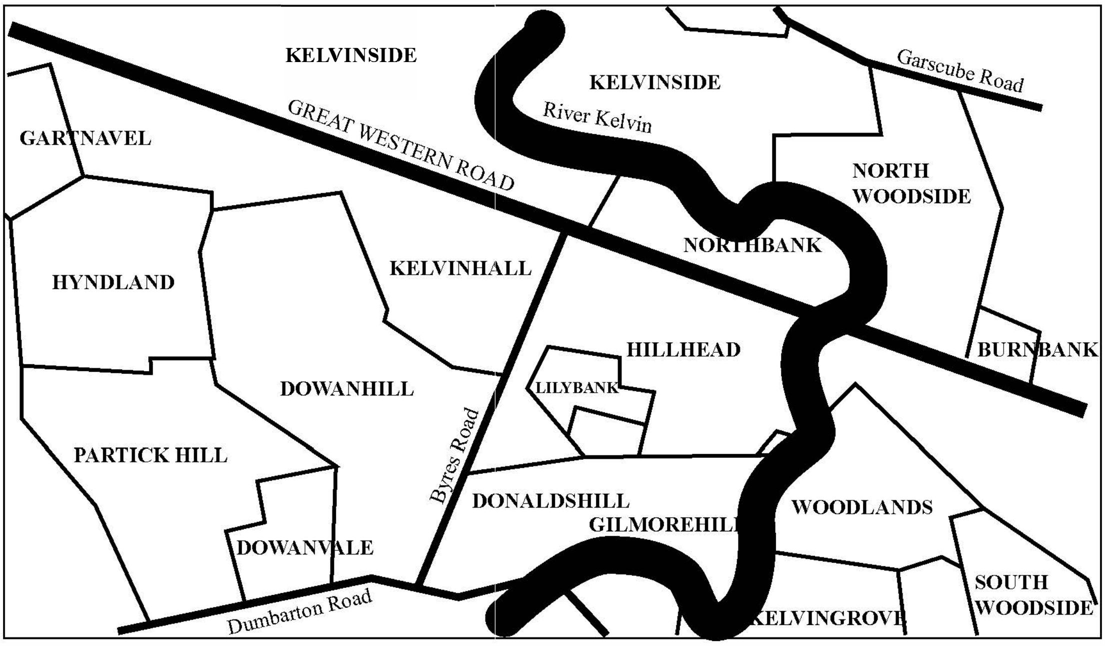


Figure 61. The Estates of Glasgow's West End. Based on a map in: (Pacione, 1995)

Architect. The Estate was to be developed with standalone sandstone villas, surrounded by large gardens, built over a suburban layout; excessive construction standards and low density in the design turned this development in a venture which was not economically viable; as a consequence, the overall development of the area slowed down considerably (Pacione, 1995) and was never able to be completed according to plan (Atherton, 1991).

The development of the estate of Hillhead on the contrary, planned with a more modern style, was based on a grid layout framed by tenement buildings; this approach was a lot more successful and demonstrated that a denser layout and a wider market audience were necessary in order to make a profitable investment and avoid bankruptcy.

The working class tenements that were built along Great Western Road presented a flexible ground floor layout that allowed for the introduction of shop units, while middle class tenements with residencies at the ground floor were built in the inner parts of the estate, were more privacy was guaranteed (Glendinning et al., 1996) (Pacione, 1995) .The schematic cross section of stretch A in Figure 62 illustrates how the residential units are detached from the street to ensure privacy as one would expect in an upper market residential estate; the schematic section of stretch B (Figure 62), is one of a typical commercial street, where the shops doors open directly onto the pavement, where the boundaries between private and public life are a lot more blurred.

At a visual examination, values of Betweenness Centrality index are high along the

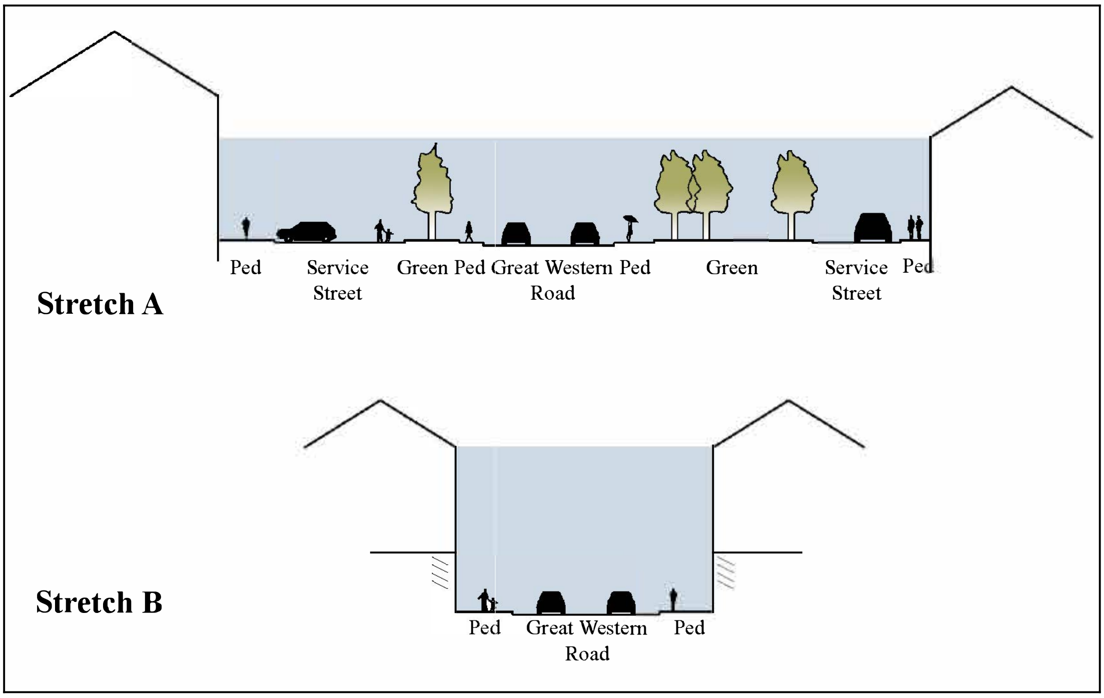


Figure 62. : Stretch A and B of Great western Road present a very different character reflecting the grandeur of n upmarket residential area in Stretch A, and a middle class residential area in Stretch B which incorporated shops at the ground floor

Figure 63. Great Western Road Stretch A (Image ©2015 Google)

Figure 64. Great Western Road Stretch B (Image ©2015 Google)

whole length of Great Western Road, from St Georges Cross, through Kelvinbridge to Anniesland and beyond, as mapped in Figure 65.

The historical patterns of construction at small scale are quite different along the extension of Great Western Road; public/ private interface, or constitutedness (see 3.5.1), is very strong in Kelvinbridge (Stretch B, Figure 62, Figure 64) and very weak after the Botanic gardens towards Anniesland (Stretch A , Figure 62, Figure 63). The commercial area along the axis is in-fact located in the Kelvinbridge area, where the typical section allows for the entrances of the shops to abute directly onto the pavement (Stretch B, Figure 62, Figure 64).

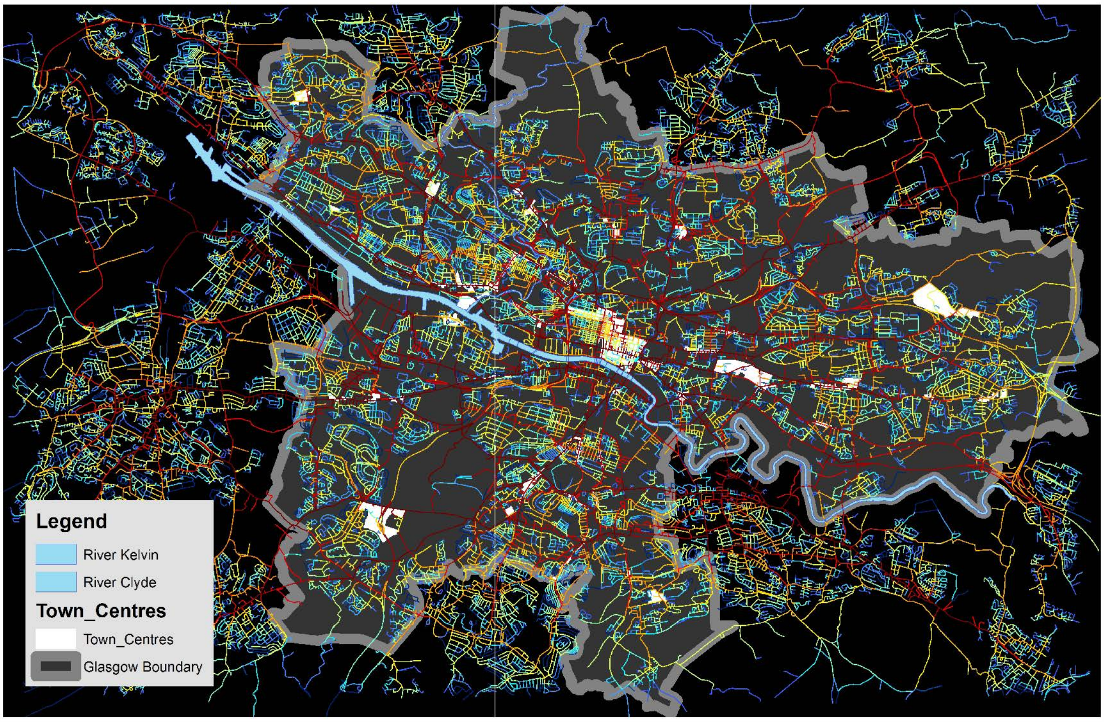


Figure 65. Betweenness Index values are very high along the whole axis of Great Western Road, starting from St Georges' Cross, through Anniesland and beyond towards the city's boundary. The Town Centres are indicated in white.

Values of the Kernel Density of the Betweenness index decrease halfway between Anniesland and Byres Road (Figure 66), as there are much less street intersections, the urban block is elongated.

The urban form present along either sides of stretch A (Stretch A , Figure 62, Figure 63) of GWR, is also less dense than in stretch B (Stretch B, Figure 62, Figure 64).

We also note the complete presence of commerce in the area where the kernel density decreases; the next commercial area is located in Anniesland, where betweenness values are high again (Figure 66).

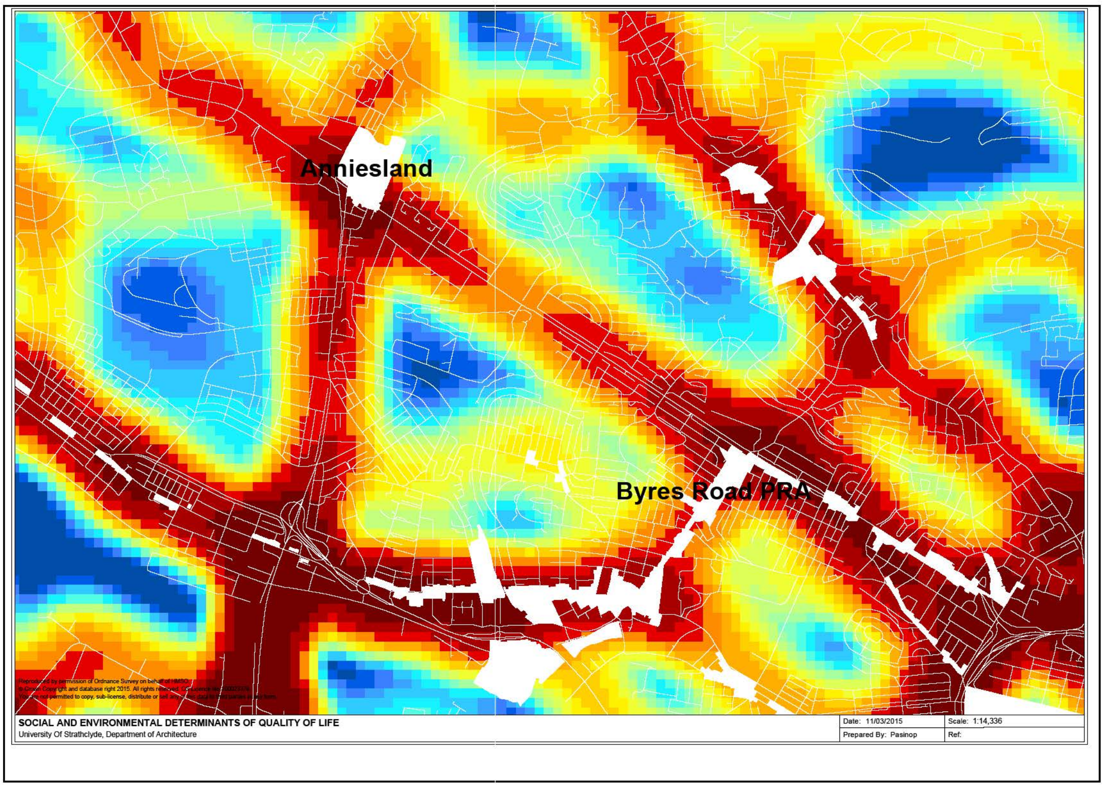


Figure 66. Kernel Density of Betweenness values along Great Western Road; the values decrease between Anniesland and the intersection of Byres Road, while remain almost constant between the intersection with Byres Road at the eastern end of GWR at St Georges Cross.

6.3.3. *Town Centres and Closeness Centrality Index*

One of the major findings of the analysis of the Betweenness index described in 6.3.2 is that organically developed town centres are traversed by high levels of Betweenness, while post war, modernist, planned town centres are surrounded by axis with high levels of Betweenness, but present low levels of the index at their core.

The analysis of the Closeness index is capable of providing a greater insight in local dynamics and to highlight the presence of spatially segregated neighbourhoods. Literature indicates that such areas can be more susceptible to social segregation as geographically disconnected areas depend more on the social mix already existing within them and due to the absence of passing traffic do not facilitate spontaneous social mixing (Lees, 2008).

Cities presenting spatially segregated areas which are not well connected into the overall network, also require a greater distribution of amenities compared to cities that present a more continuous urban network, in order to avoid the exclusion of large segments of the population from commercial and cultural services (Atkinson et al., 2004), and are less cost effective to run.

A primary interest for the study of accessibility at different levels, whether it is Local, Neighbourhood or District, is to explore the potential for a thriving civic life, lively streets and interaction in public space as preconditions for a successful urban environment (Jacobs, 1961).

Further to this, it is expected that organically developed Town Centres should be surrounded by areas with high levels of Closeness at 400m index, while Planned Town Centres should be at the centres of areas with low levels of Closeness at 400m index.

To explore this scenario, the Town Centres in Glasgow have been divided into two categories:

1. Organically Developed: Town Centres developed organically from an existing historical core.
2. Planned: Town Centre located at the core of post war modernist housing schemes.

Interwar developments are a hybrid between the two categories and need to be examined

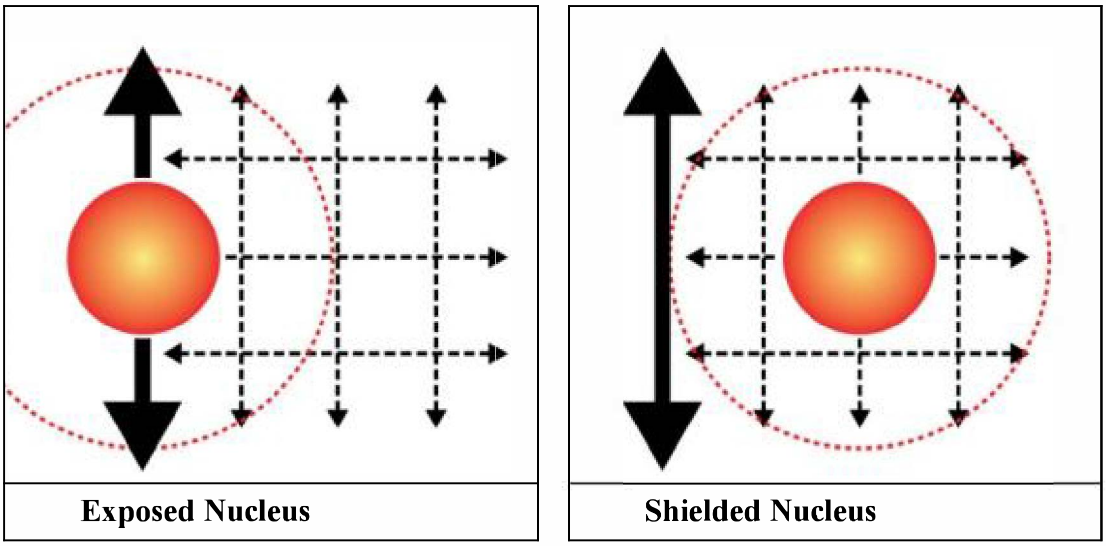


Figure 67. Should and urban centre be planned at the edge of at the centre of a residential community? Organically developed settlements present an exposed nucleus scenario, where the high street, the axis connecting the local level to the global level, traverses the commercial street; the axis presents high levels of Betweenness and is surrounded by residential areas. Post War, modernists, planned developments include their commercial nucleus in the middle of the residential area, and thoroughfares are kept at the external edges (Mehaffy et al., 2010).

on a case-by-case basis.

The categorization was implemented by dating the development of each Town Centre through the examination of Glasgow's OS maps dated 1860, 1890, 1910, 1950, 1960, 1970, 1980 and the most recent one available 2012 (Table 10).

Table 10. Dates of developments of Glasgow's Town Centres. The dates reported in the table indicate when the development appeared on the OS map and not the precise year of development. OS map year 1 indicates the OS map illustrating the development for the first time; OS map year 2, indicates the OS map that illustrates the urban form as it appears toady. The observations are brief notes taken during the consolation of the OS maps and are just reminders for the researcher.

Town Centre Name	OS map year 1	OS map year 2	Organically Developed	Planned	Interwar	Comments
Albert Drive	1890	1890	✓			
Alexandra Parade	1910	1910	✓			
Anniesland	1890	1950	✓			First expansion along GWR in 1890. By 1910 further residential expansion along Fulton Street. Fully developed by 1950
Anniesland PRA			✓			
Baillieston	1860	1960		✓		Fully developed by 1960
Baillieston Edge	1860			✓		Fully developed by 1960
Barrachnie	1860	2012		✓		Big development east of TC in 1950; further development from 1980s to current 2012 maps
Battlefield	1890	1910	✓			
Bridgeton	1860		✓			Fully developed by 1860; historic urban form mostly retained
Byres Road PRA	1890	1910	✓			
Cardonald/ Halfway	1860	1950		✓		Fully developed at 1950s - post war
Cardonald/ Halfway Edge	1860	1950		✓		Fully developed at 1950s - post war
Castlemilk	1860	1950		✓		Just 3 buildings between 1860 and 1910; no change. Developed in 1950 - post war
Cathcart/Muirend	1860	1910			✓	Fully developed by 1950

Cessnock	1890	1950	✓			Fully developed by 1950
City Centre	1860		✓			
City Centre Edge	1860		✓			
City Centre Edge	1860		✓			
City Centre Edge	1860		✓			
City Centre Edge	1860		✓			
Cranstonhill/ Yorkhill	1860	1910	✓			
Croftfoot	1950	1960		✓		Full development between 1950 and 1960
Drumchapel	1960			✓		Planned in 1951; peak in 1961 it housed 35.000 people designed as a semi dependent town with its own centre (like Pollock, Castlemilk, Easterhouse)
Duke Street	1860	1890	✓			
Duke Street Edge	1860	1890	✓			
Easterhouse	1960	1960		✓		
Gorbals	1860	2012		✓		The urban form of the Gorbals is completely changed from the original 1860s development. In the 1960s the existing tenements were deemed unsanitary and demolished to be replaced by a mixture of 8 storey flats and 20 storey tower blocks. The residential buildings resulted to be unsuitable for the Scottish climate and were replaced by the Crown Street regeneration project starting from 1992 (Pacione, 2009).
Govan	1860	1980	✓			Urban form changed greatly south and west of Town Centre from 1980s
Govanhill	1890	1910	✓			
Hyndland	1890	1950	✓			Fully developed by 1950s; 1910 map missing; further developments after 1980s
Kelvinbridge	1860	1890	✓			
Knightswood	1860	1950			✓	Knighstwood was developed with low density cottage style houses and four in a block apartments. It is Glasgow's third largest interwar estate (Williamson et al., 1990).
Maryhill	1860	1910	✓	✓	✓	Further interwar expansions and then after 1950s
Mount Florida	1890	1910	✓		✓	Further interwar expansions
Parkhead	1860	1910	✓			Fully developed by 1910; historical urban form retained
Parkhead Edge						
Partick PRA	1860	1890	✓			Fully developed by 1890; historical urban form retained

Partick/Byres Road	1890	1910	✓			Fully developed by 1910; historical urban form retained
Partick/Byres Road Edge	1860		✓			
Partick/Byres Road Edge	1860		✓			Shipbuilding site
Pollok	1950			✓		
Pollok Edge	1950			✓		
Possilpark	1860	1950		✓		High street established in 1860; Fully developed in the 1950s
Possilpark Edge	1950			✓		
Scotstoun / Whiteinch	1890	1910	✓			Fully developed by 1910; historical urban form retained
Shawlands	1860	1910	✓			Fully developed by 1910; historical urban form retained
Shawlands Edge						
Shawlands PRA						
Shettleston	1860	1910	✓			1950 further development
Springburn	1860	1970		✓		The original urban centre of Springburn has undergone a complete transformation from the 1970s to the early 1980s. As one of the Comprehensive Development Areas Springburn had 85% of its buildings demolished and replaced by a series of housing estates. The dual carriageway, which severs the centre in two, was completed in 1988. The few Victorian Villas around Balgrayhill and sandstone tenements around Keppochill Road and Central Springburn which survived the demolitions are just a small reminder of its former glory (Williamson et al., 1990).
St George's Cross	1860	1890	✓			Fully developed by 1890; historical urban form changed with M8 in 1960-70
Strathbungo	1890	1910	✓			Fully developed by 1910; historical urban form retained
The Barras	1860	1910	✓			Fully developed by 1910; historical urban form retained
Tollcross	1860	1950	✓			Fully developed by 1910; historical urban form retained
Victoria Road	1890	1910	✓			Fully developed by 1910; historical urban form retained
Victoria Road Edge	1890	1910	✓			Fully developed by 1910; historical urban form retained
Victoria Road PRA	1890	1890	✓			Fully developed by 1910; historical urban form retained
Woodlands	1860	1910	✓			Fully developed by 1910; historical urban form retained
Yoker	1910	1950	✓			

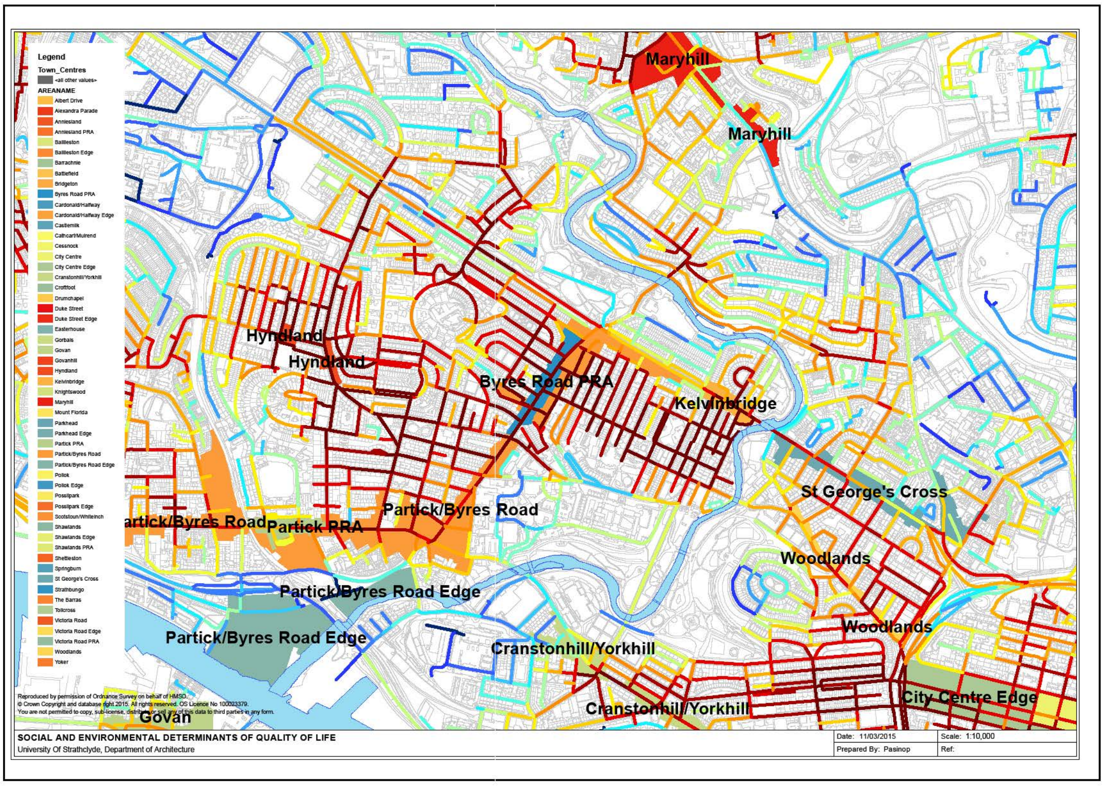


Figure 68. Closeness @400 m around Byres Road Town Centre, in the busy West End of Glasgow.

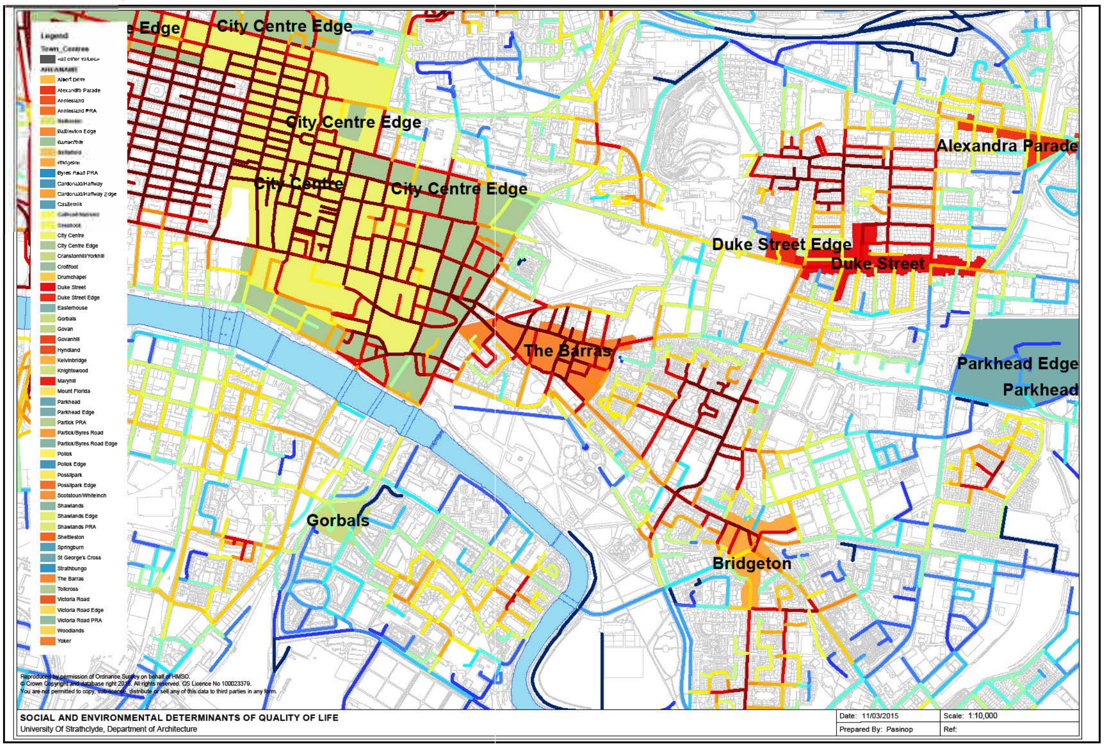


Figure 69. Closeness @400 m around The Barras, Duke Street, Bridgeton in the East End Of Glasgow. These three town centres have high streets with levels of Betweenness index and are surrounded by residential areas with high levels of Closeness @400m; such areas are easily navigable on foot. The area of Duke Street in particular has been undergoing a spontaneous gentrification in the past ten years: the high street is lively, the sandstone tenements very appealing, and from there the City Centre can be reached on foot.

The second step was to map each town centre illustrating the variation of the Closeness at 400m index; the maps for each town centre are contained in Appendix 2: Town Centres and Closeness @400m Index.

The maps confirm our original hypothesis; Byres Road, an organically developed Town Centre (Figure 68) is surrounded by residential areas developed between 1890 and 1910, which present high levels of Closeness @ 400m.

The same scenario applies just East of the City Centre, around the Town Centres of The Barras, Bridgeton and Duke Street; the Town Centres are surrounded by residential areas, which by en large retained their original urban form, and are still easily navigable on foot (Figure 69). These areas present high levels of Closeness @400m centrality

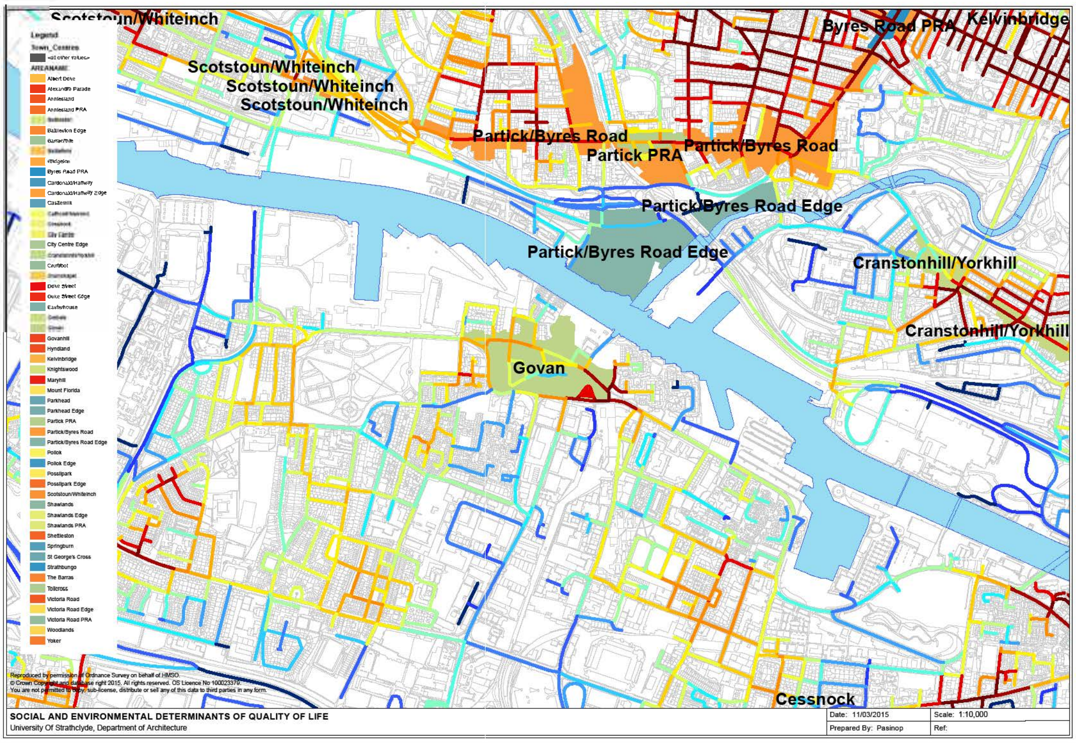


Figure 70. Govan Town Centre has developed organically but the urban form around it has substantially changed as a consequence of the processes of deindustrialization. Levels of Closeness @400m centrality are still high where the urban form was retained.

index.

The Exposed Nuclei examples illustrated by Byres Road, the East End Town Centres and partly Govan Town Centre (Figure 70) is consistent throughout the Organically Developed Town Centres and the full extent of the mapping can be consulted in Appendix 2: Town Centres and Closeness @400m Index.

The Town Centres which do not present the same situation are the ones located at the centre of post war developments, which were planned according to modernist ideals; they present generally low levels of Closeness@400m centrality index due to their layouts, which are not permeable and easy to navigate on foot (Figure 71, Figure 72, Figure 73).

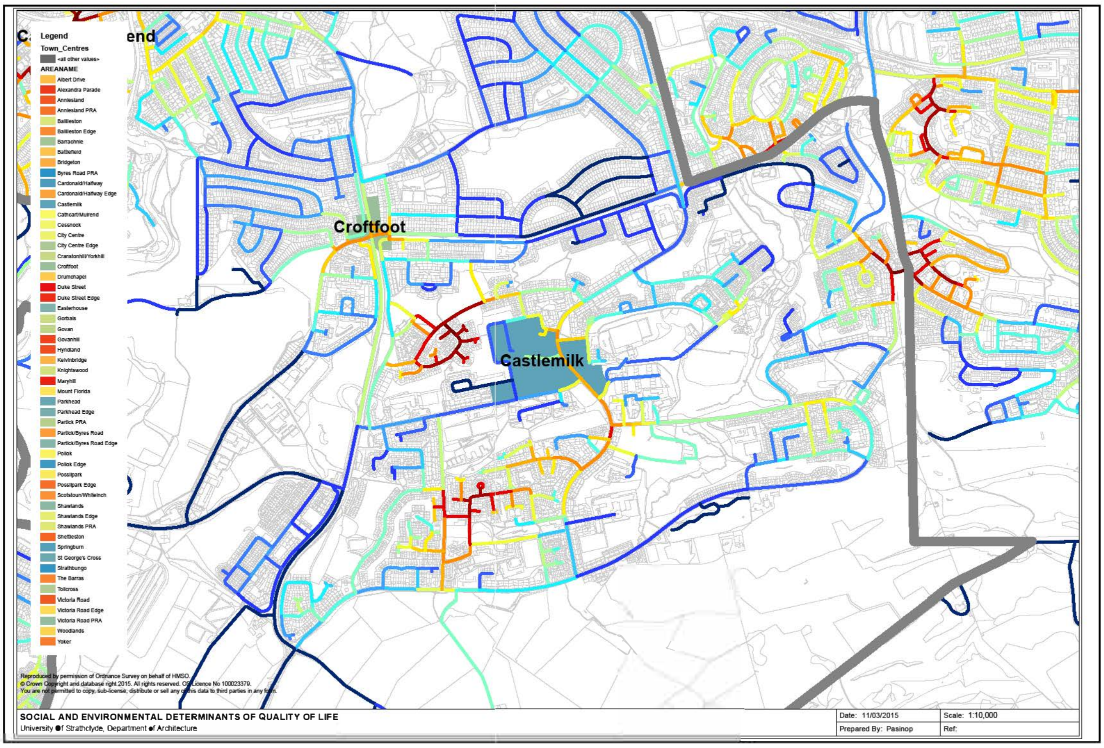


Figure 71. Castlemilk Town Centre is set at the centre of the housing scheme (Shielded Nucleus) and is surrounded by an area with low values of Closeness Centrality @400m Index. The urban form around the Town Centre presents a typical suburban layout where the urban block is lost, intersections are further away that 400m and cul de sacs are very frequent

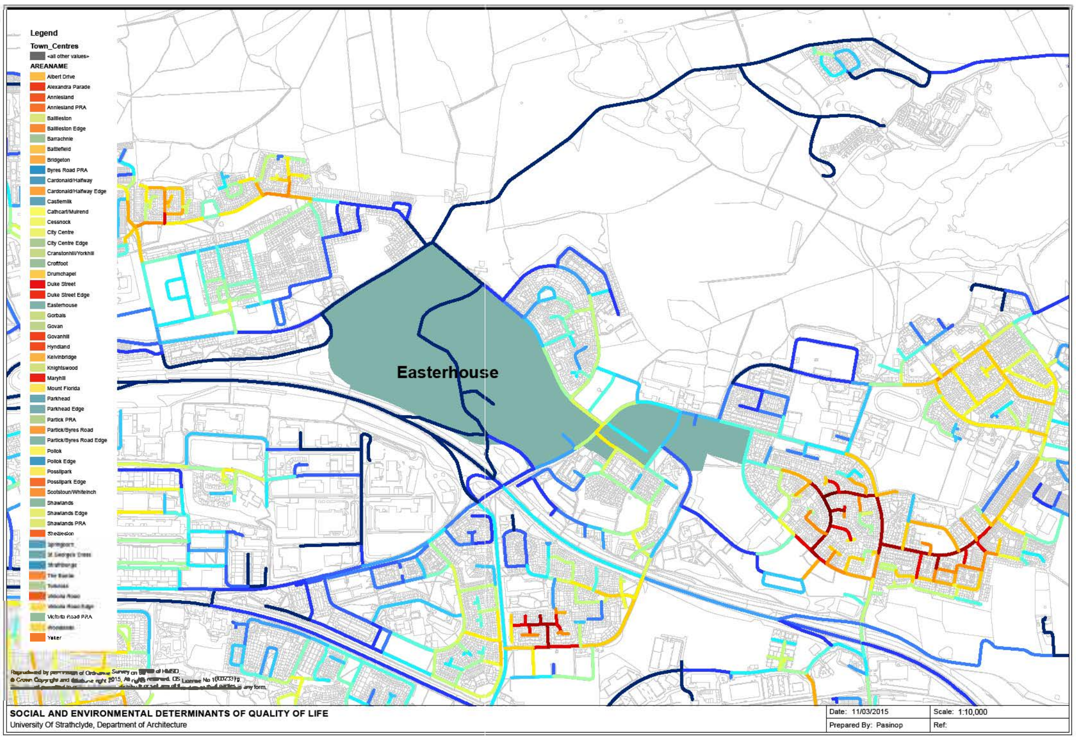


Figure 73. Easterhouse Town Centre is set at the centre of the housing scheme (Shielded Nucleus) and is surrounded by an area with low values of Closeness Centrality @400m Index.

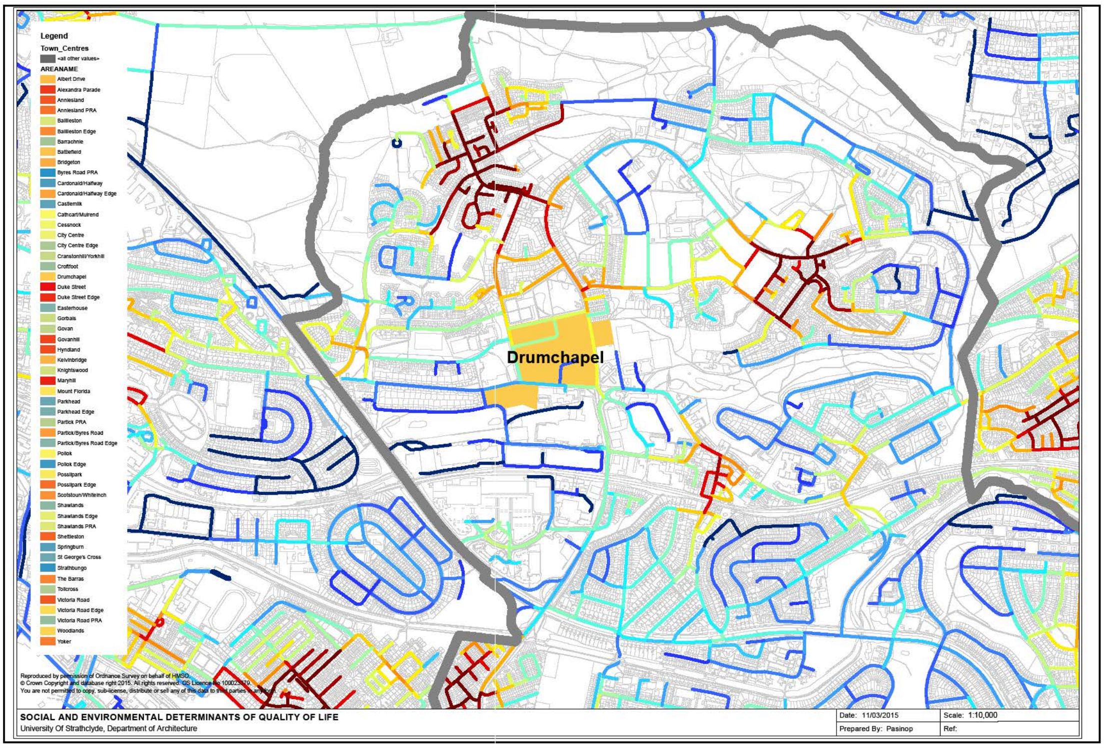


Figure 72. Drumchapel Town Centre is set at the centre of the housing scheme (Shielded Nucleus) and is surrounded by an area with low values of Closeness Centrality @400m Index.

The Interwar development of Knighstwood is a hybrid of the above scenarios. Whilst the developments is situated at the side of an existing historical Town Centre, it presents a garden suburb layout where villas and 4 in a block apartment are distributed in elongated blocks with the occasional crescent; the increase in length of the traditional block results in a layout that is no longer easily navigable on foot (Frey, 2003). Levels of Closeness @400m are low throughout the residential development, as expected (Figure 74).

The city centre of Glasgow performs extremely well in terms of Closeness @400m (Figure 76).

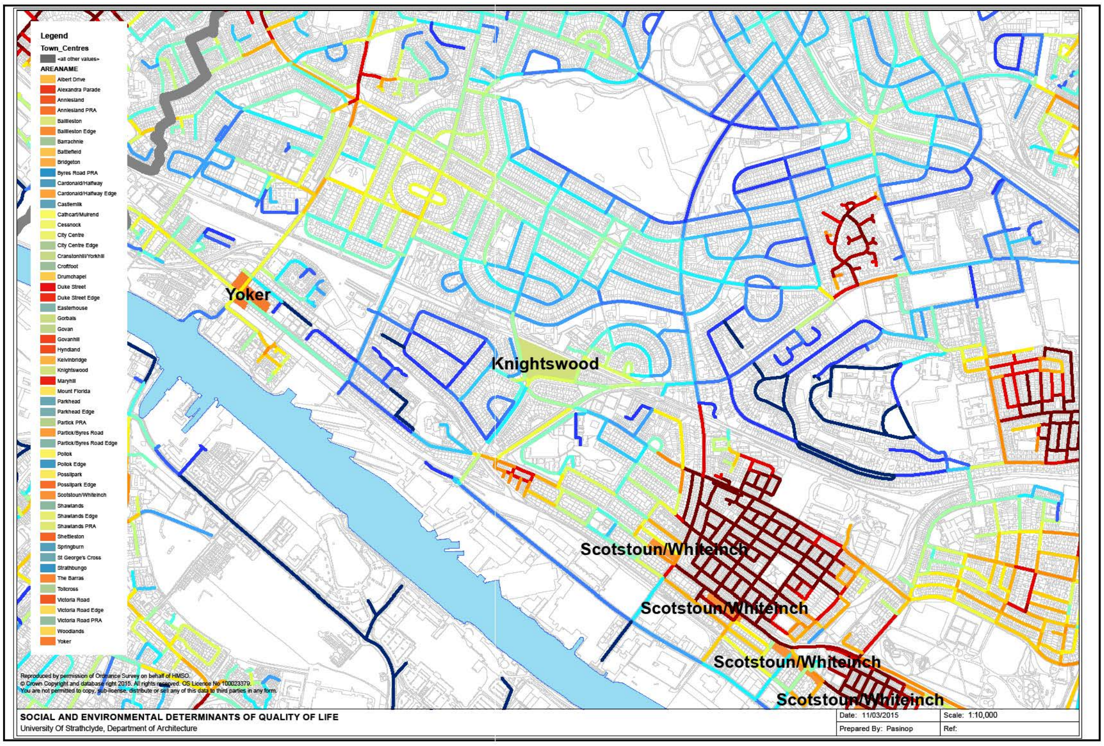


Figure 74. : The interwar development of Knightswood is the third largest in Glasgow. Its development started in the 1920s with two storey cottages and cottage flats; in later phases the specifications of the construction had to be downgraded due to costs constraints (Williamson et al., 1990).

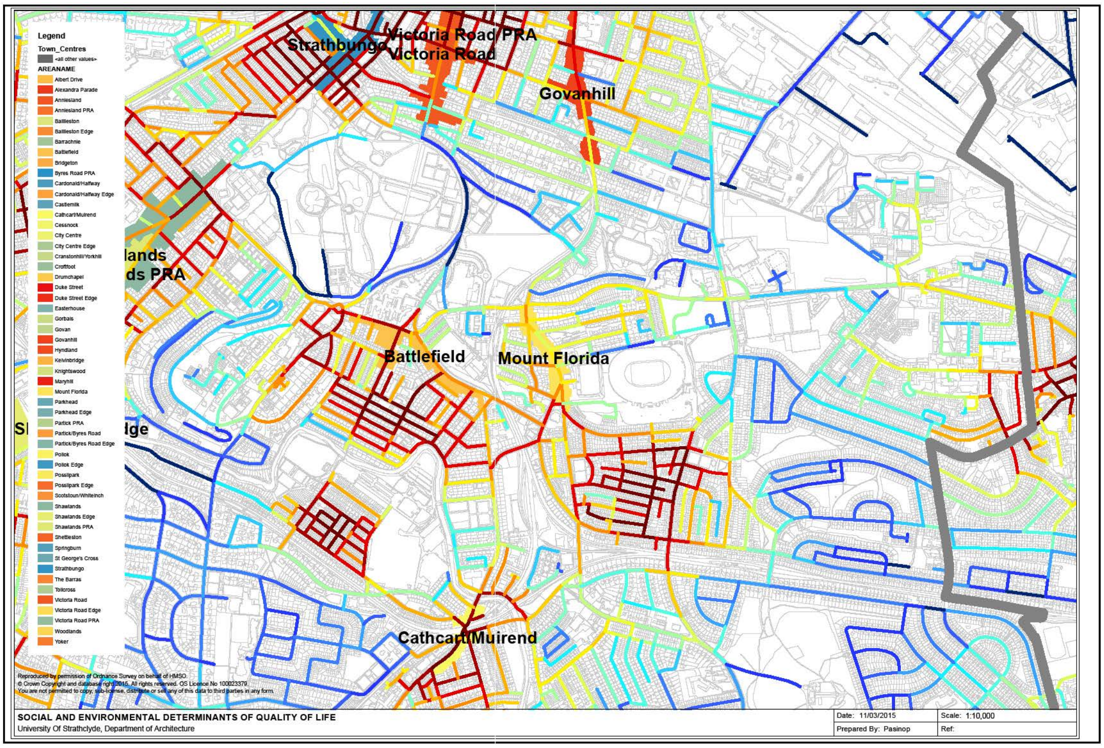


Figure 75. : Mount Florida is another of Glasgow's interwar developments; with a similar garden suburb layout as Knightswood the levels of Closeness @400m centrality index are not high.

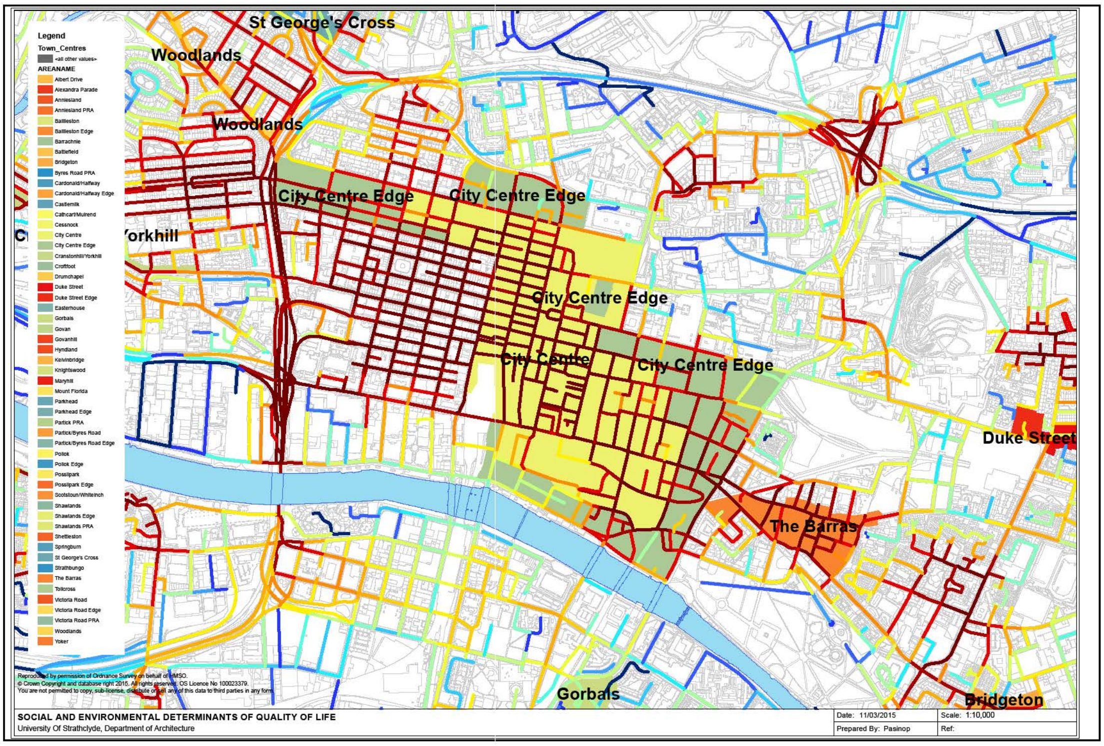


Figure 76. The core of Glasgow's city centre performs extremely well in terms of Closeness @400m. This portion of the city is based on an iron grid layout, which makes it extremely easy to navigate on foot. A system of secondary lanes spread throughout the city centre increases the overall permeability of this area.

We note that street intersections are dense in this area; according to new urbanism and neo traditional planning literature, street connectivity is one of the key elements for the good functioning of a neighbourhood.

Street networks that are more grid like allow for better connectivity as they avoid increasing distances between destinations through cul de sacs and long blocks; such long distances are thought to discourage active travelling and healthy life styles.

Measuring connectivity can be useful when establishing a link between travel behaviours (active travel and health), to urban form (Dill, 2004).

The closeness @400m centrality index is an indicator of connectivity and we will compare it to Intersection Density, another common indicator for connectivity, alongside with Block Length, Block Size, Block Density, Street Density etc.

Intersection density is measured as the number of intersections per unit area. The higher the number of intersections in the unit area, the higher the connectivity (Figure 77) (Dill, 2004). To be highly permeable a street network should present a high proportion of four-way intersections, few cul-de-sacs, and traditional street block sizes (about 400m apart) (Porta et al., 2005).

The type of intersection is an important element; the presence of a high percentage of cul de sacs is an indication of low connectivity, while a high percentage of 3 and 4 ways junctions is an indication of high connectivity, when associated with small block sizes (Porta et al., 2005).

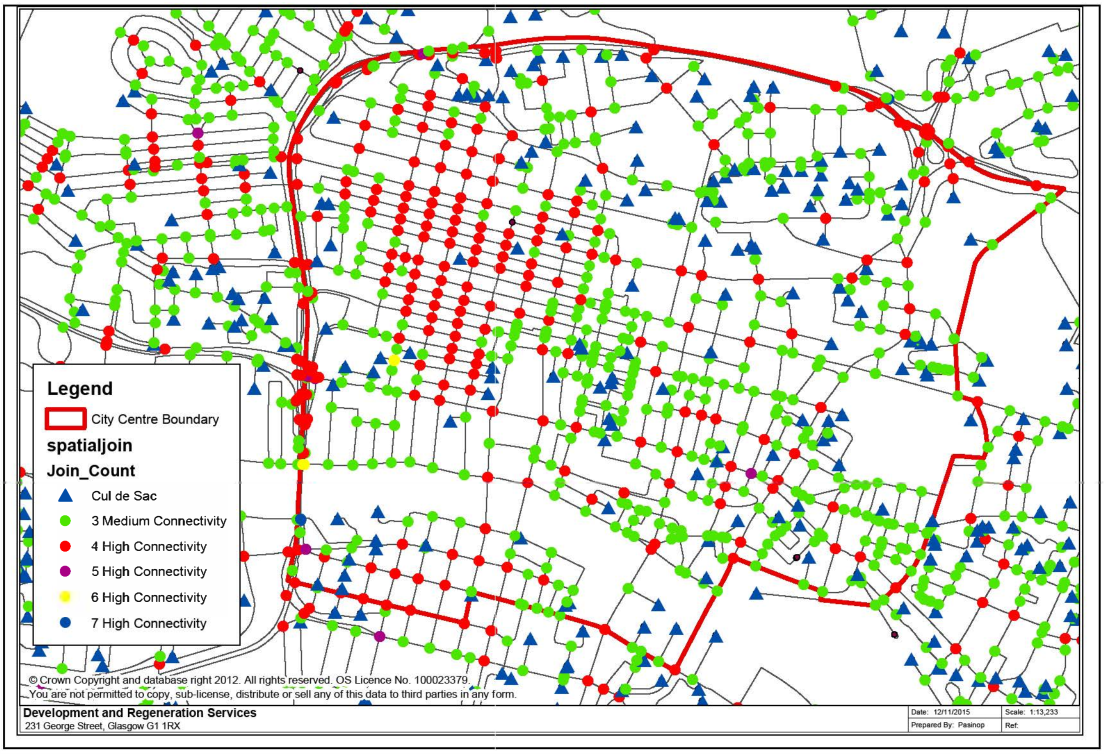


Figure 77. Street junctions have been codified in ArcGis; working with the layer of the middle lines of the streets, each street junction has been assigned a node. The number of intersections is calculated for each node through spatial join.

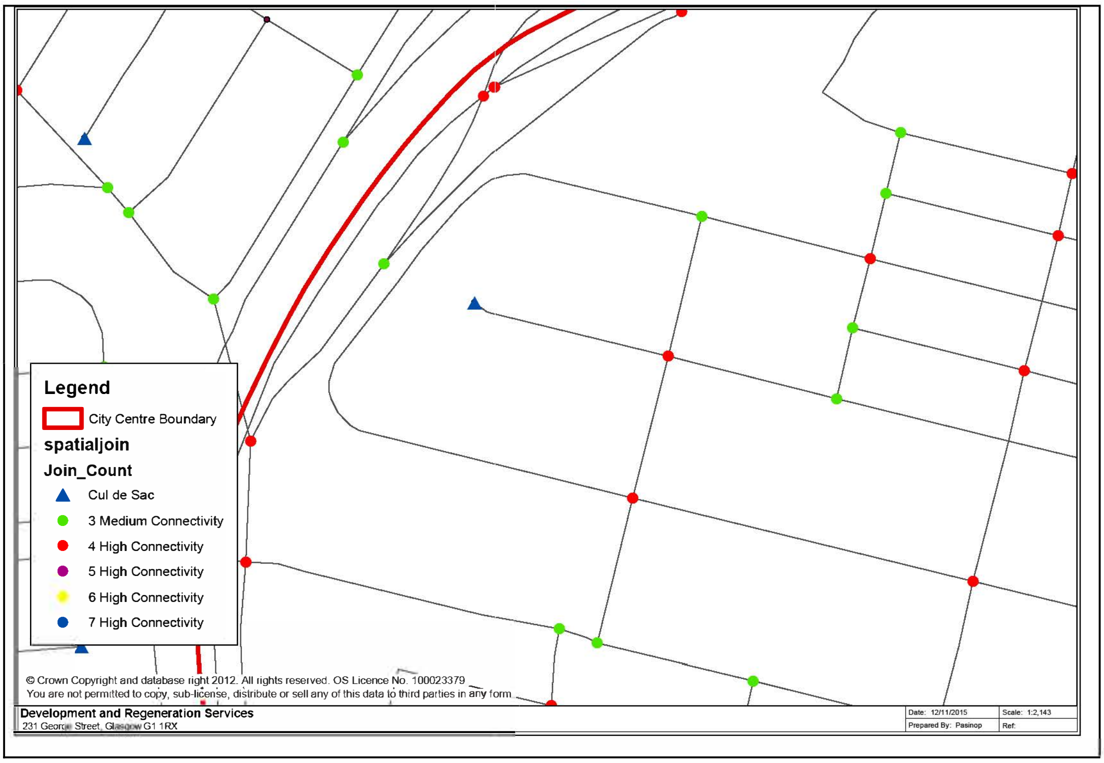
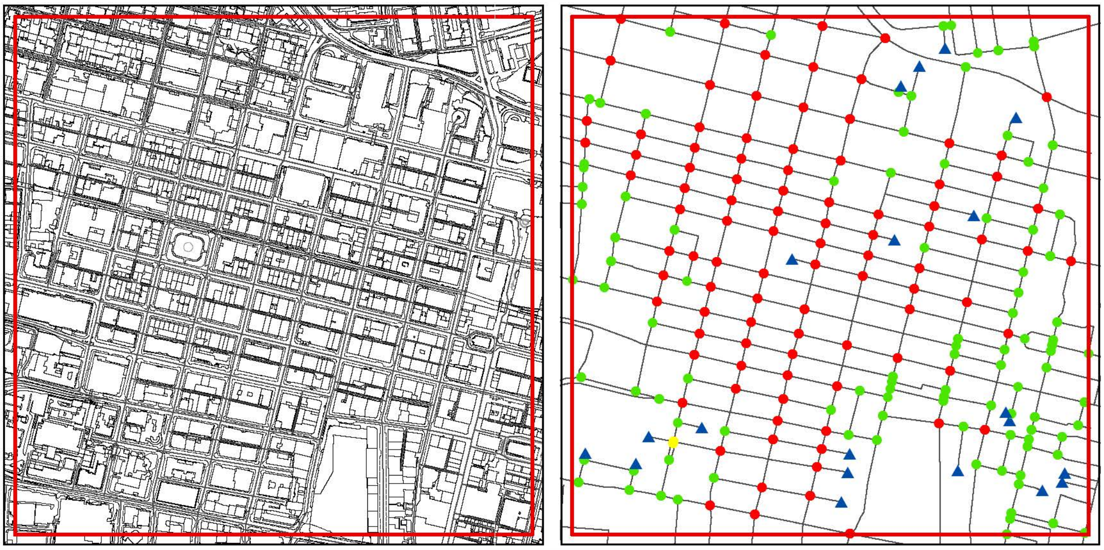
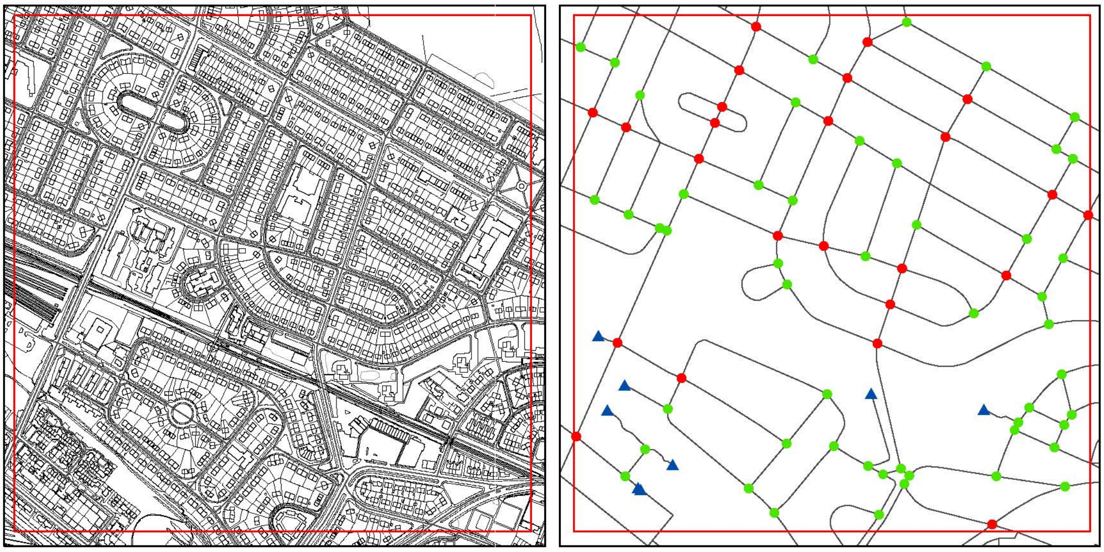


Figure 78. A node with value 1 is a cul de sac, value 2 does not offer a choice of change of direction and is therefore not mapped, value 3 is a 3 ways junction and indicates medium connectivity, value 4 is a 4 four ways junction and indicates High connectivity. Values above 4 are rarer and indicate extremely high connectivity (Porta et al., 2005). Each node is then assigned a weighted value according to the number of intersections associated with it (1 intersection= -1; 3 intersections= 1; >3 intersections=2). (Dunham-Jones et al., 2011)

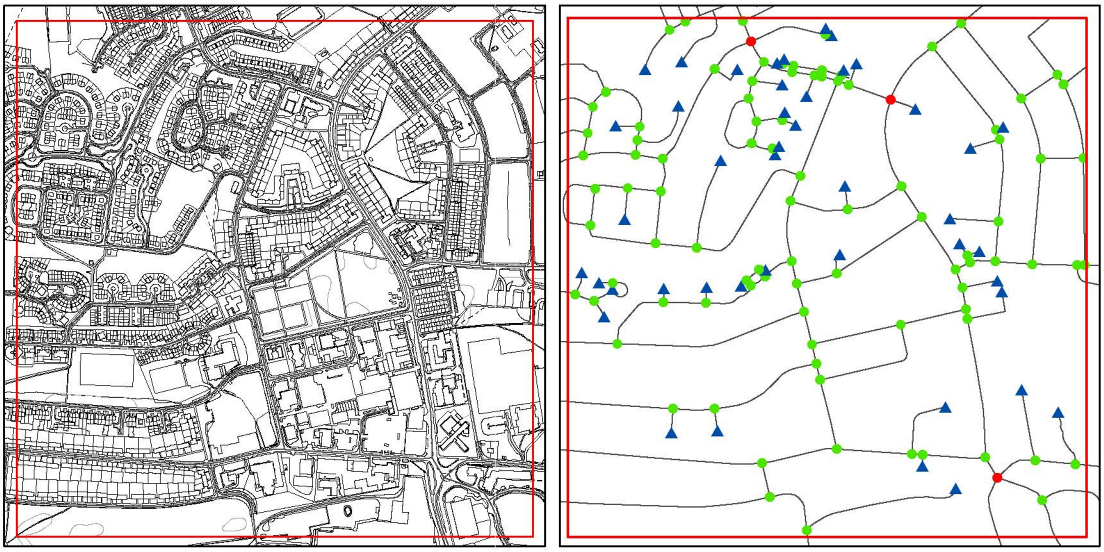


*(a). City Centre , **1 kmx1km** square – Victorian: 235 junctions; weighted index: 984. The area is well connected, it presents a high majority of 3 and 4 ways junctions.*



(b). Knightswood – interwar: 94 junctions; weighted index: 323

(c). Castlemilk – post war development: 144 junctions; weighted index: 186



(c). Drumchapel – post war development: 153 junctions; weighted index: 224

Figure 79. Junction density; the urban form of four areas with different age of development in Glasgow has been sampled in a 1000 x 1000 m square. The City Centre sample presents the highest number of junctions and therefore has better connectivity. It is worth observing the almost complete lack of 4 ways junctions in the post war developments; Knightswood presents a significant number of 4 ways junctions even if 3 ways junctions are still predominant. The City Centre presents a higher number of 4 ways junctions than of 3 ways junctions. As to be expected, cul de sacs are much more common in the post war developments samples.

Table 11. The type of intersections in an area has a direct effect on people's movement and on space legibility. The table reports the findings on the four sample areas analysed in Glasgow (City Centre, Knightswood, Easterhouse and Drumchapel- Figure 79). To be highly permeable an area should present a high proportion of 4 ways intersections (or above), not many cul de sacs and block sizes close to a 400m size (Porta et al., 2005).

	City Centre	**Knightswood**	**Drumchapel**	**Castlemilk**
Cul de Sacs	3.0%	3.29%	14.62%	20.00%
3 ways junctions	40.5%	57.20%	81.06%	80.00%
4 ways junctions	55.2%	39.51%	3.99%	
6 ways junctions	1.1%			

The analysis of the junctions typologies reported in Table 11 confirms that the sample of the City Centre offers a better space legibility than any of the other samples. Infact the city Centre offers very few cul de sacs and a very high percentage of 4 ways junctions. Knightswood performs well too, but block sizes are elongated, therefore the urban

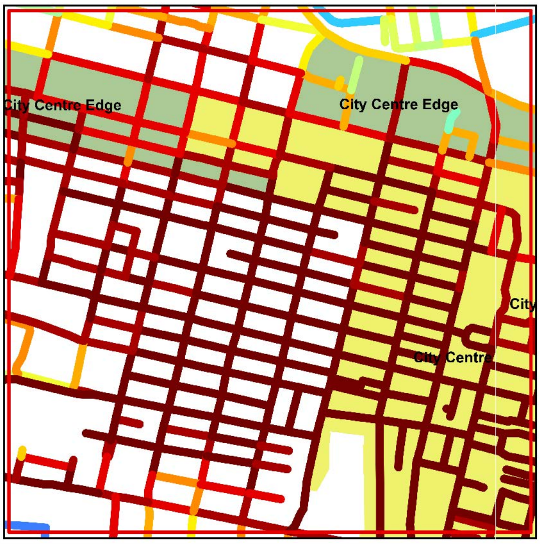
Figure 80. Knightswood 1925. The image of a newly constructed Knightswood is somehow overwhelming with rows and rows of similar looking houses surrounded by fields. (Source: http://www.bbc.co.uk/scotland/landscapes/knightswood/)

form is not quite as permeable.

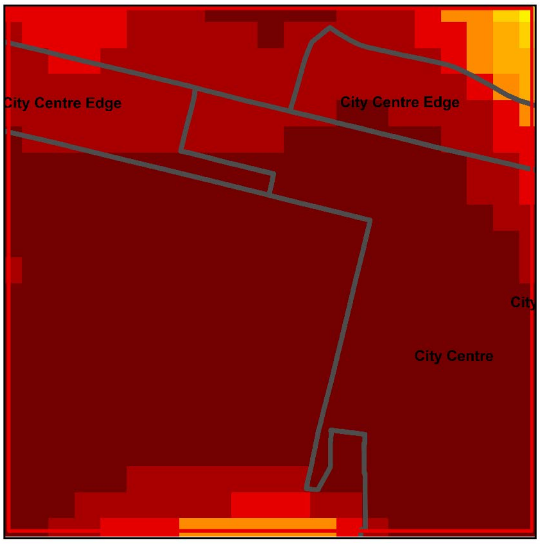
The two post war developments samples (Drumchapel and Castlemilk) perform really poorly in this analysis, with high percentages of cul de sacs and very low percentages, and in case of Castlemilk, complete absence, of 4 ways junctions.

The same portions of urban network represented in the 1000x1000m squares in Figure 79, are illustrated in Figure 81, but this time, the squares contain a snapshot of the Closeness @400m centrality index (calculated over the whole network) and of the Kernel Density of the street junctions.

In both the case of interwar and post war developments, the areas that perform better

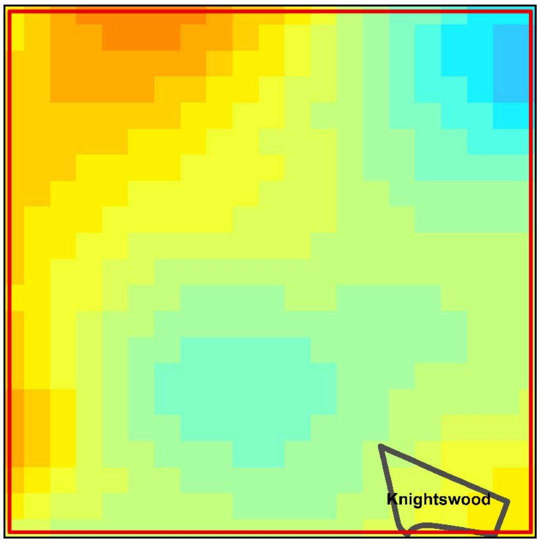


(a.1) City Centre – Victorian; Closeness @400m

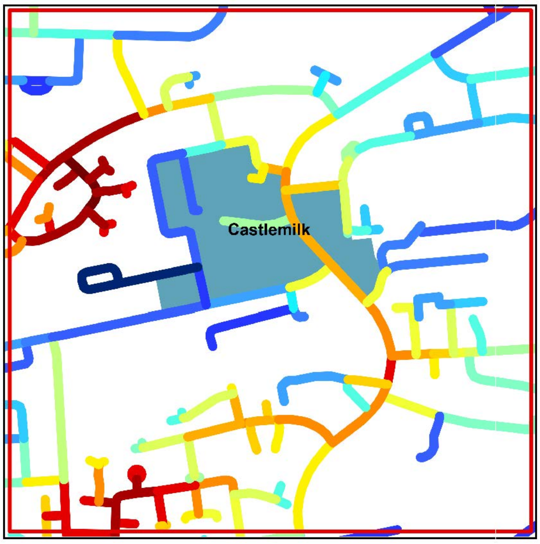


(a.2) City Centre – Victorian; Junction Kernel Density

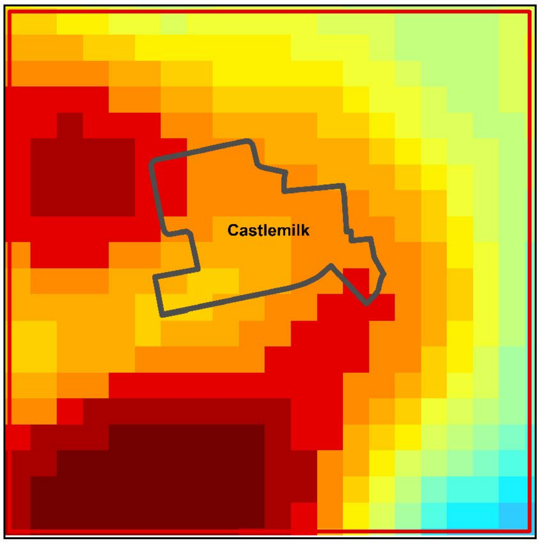
(b.1)Knightswood – interwar; Closeness @400m



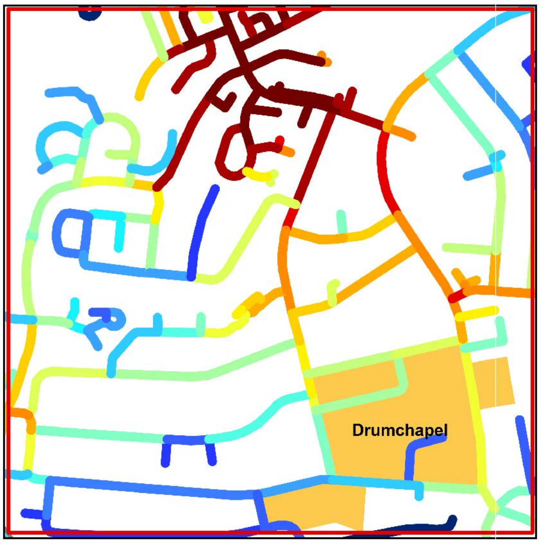
(a.2) Knightswood – interwar; Junction Kernel Density



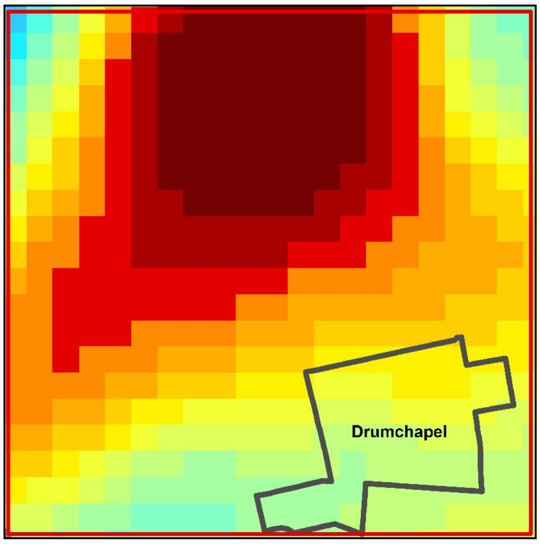
(c.1) Castlemilk – post war; Closeness @400m



(c.2) Castlemilk – post war; Junction Kernel Density



(d.1) Drumchapel – post war; Closeness @400m



(d.2) Drumchapel – post war; Junction Kernel Density

Figure 81. The Closeness @400meters and the Kernel Density of the street junctions indicate the City Centre is highly permeable and navigable, while Knigthswood, not withstanding the grid layout, looses in permeability and Closeness @400 values are low due to the elongated blocks. Both Castlemilk and Drumchapel present isolated areas where the Closeness @400m presents high values; such areas though are detached from the rest of the housing scheme and most importantly from the Town Centre itself so they do not contribute to the overall permeability of the area. The Closeness @400m centrality index and the Kernel Density of the street junctions are two different ways of assessing accessibility but as we can see from the images tell a very similar story. The advantage of the Closeness @ 400 m index is that it is calculated over the street axis so it of easier legibility and offers more flexibility to the designer who might want to explore the possibility on increasing permeability through the addition of new links in strategic positions.

in terms of Closeness @400 m are detached from the Town Centre and do not link the residential areas to the service – commercial areas effectively.

The lack of accessibility between residential areas and service/commercial areas is linked to a lack of co-presence in space which can result in issues of isolation and segregation; areas that are more geographically isolated depend on the social mix of the residents within the locality, while areas that are integrated in an urban environment are more likely to be influenced by neighbouring areas and to benefit from a greater social mix (Vaughan et al., 2005).

The City can be analysed at Neighbourhood level and at District level through the

Closeness @800 m and Closeness @1600m, we note though that the focus of this thesis is how people respond to the built environment at local level, while walking about their day-to-day activities therefore it concentrates mostly on the outputs of the Closeness index @400m.

The maps of the Closeness @1600 in Figure 80 and the density of junctions in Figure 81 reveal how the city centre in Glasgow is well connected to the West End and to the beginning of the East End; then the accessibility levels drop dramatically and become a lot more localized.

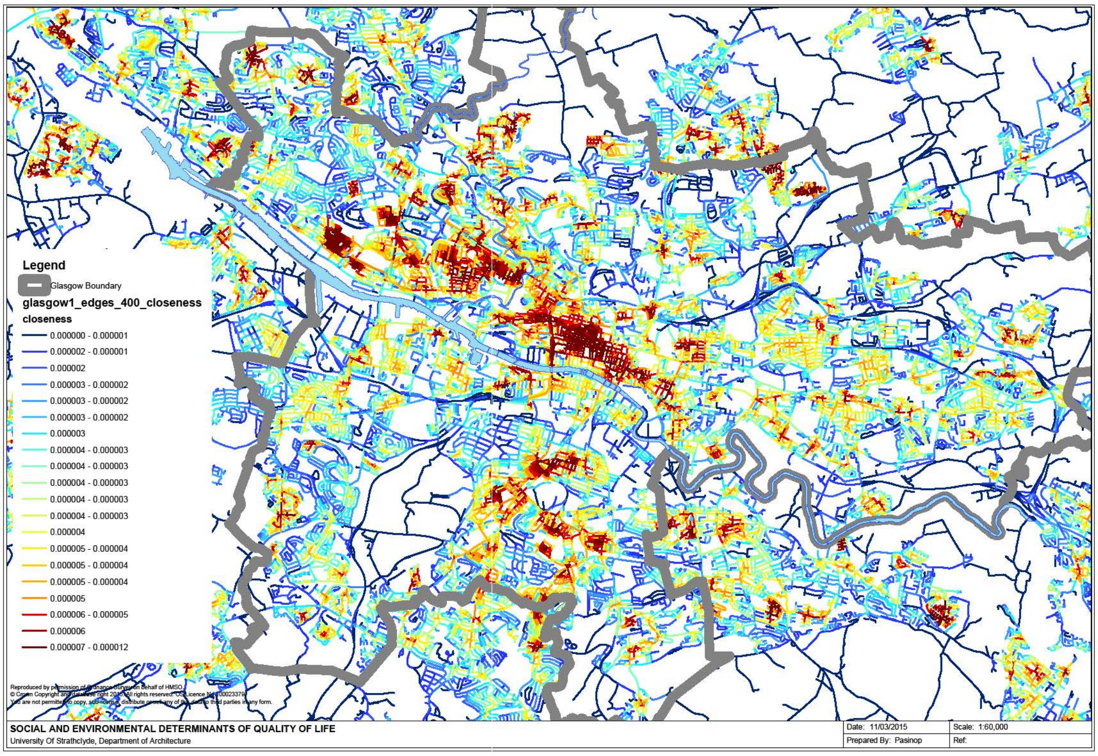


Figure 82. Closeness @400m calculated over the urban network in Glasgow

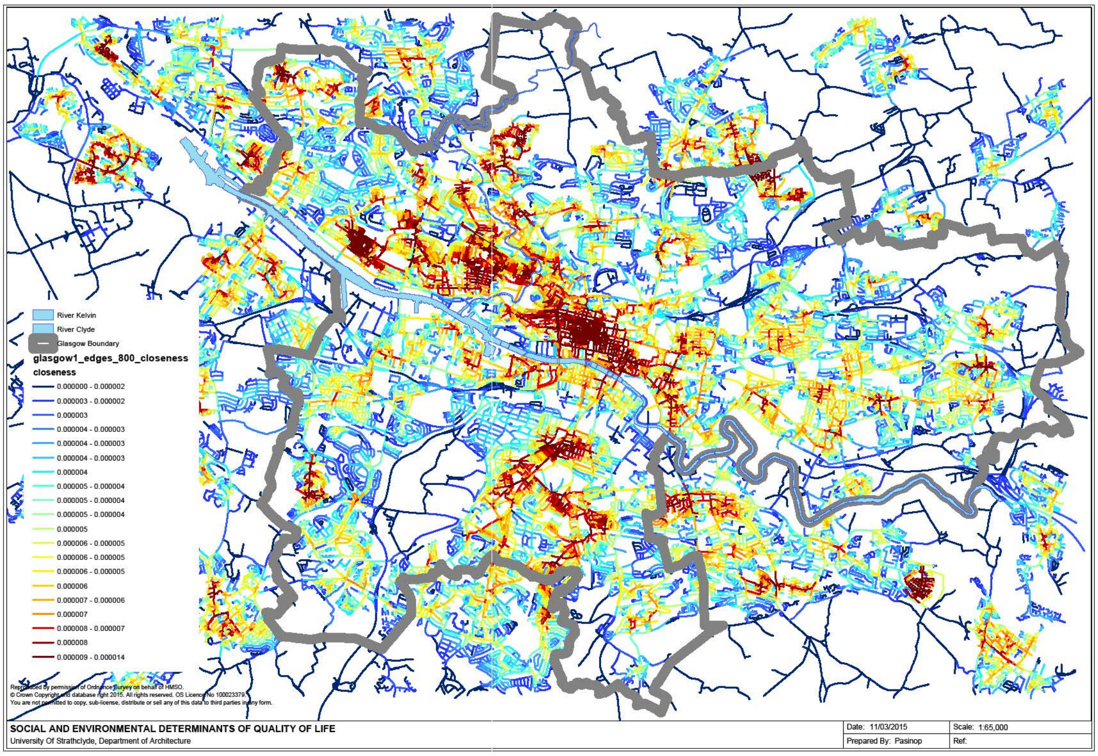


Figure 83. Closeness @800m calculated over the urban network in Glasgow

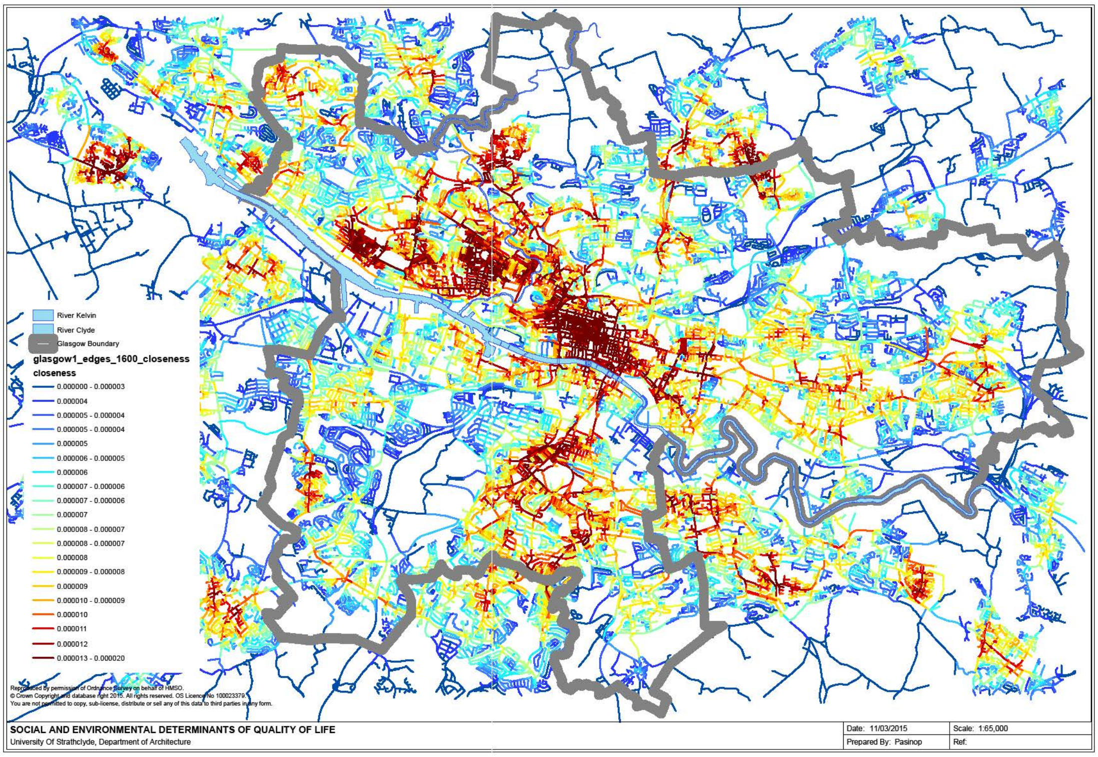


Figure 84. Closeness @1600m calculated over the urban network of Glasgow. As the radius of the Closeness lengthens, so does the area covered by high values around the City Centre which now connects seamlessly with the West End and the East End, showing that these areas of the city are easily reachable, for example, on a bicycle, which increases our speed of movement and allows us to cover bigger distances than on foot.

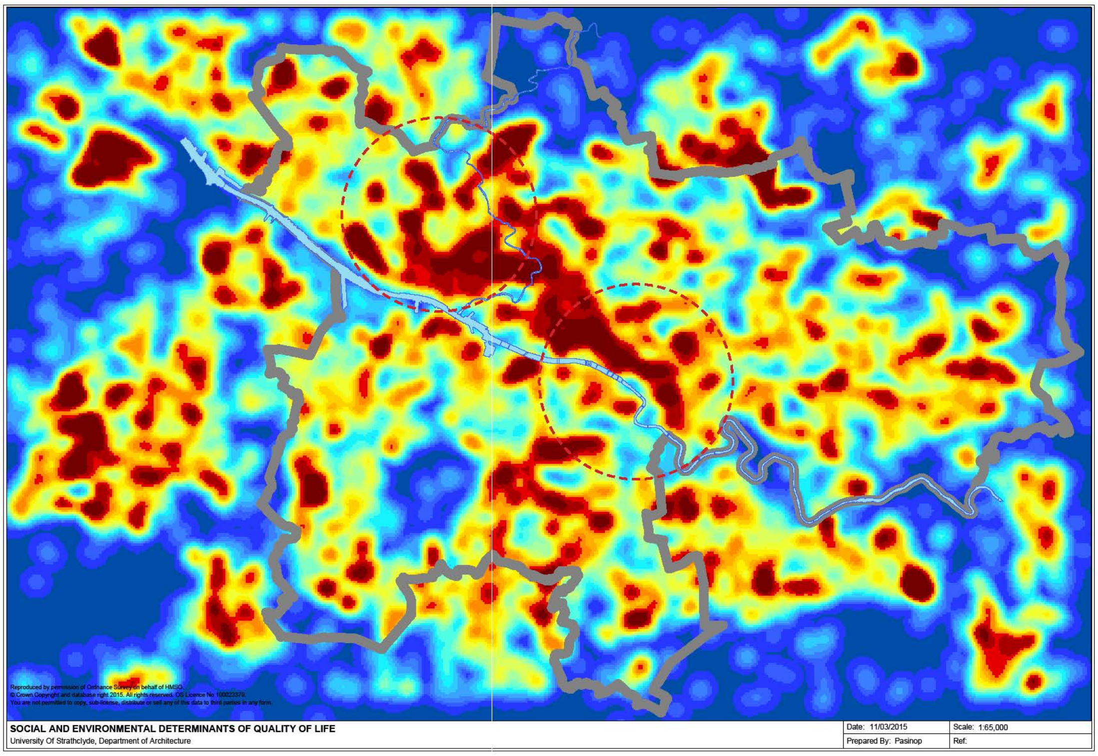


Figure 85. At a visual examination, the Kernel Density of the street junctions in Glasgow presents a similar distribution of high values to the map of the closeness @1600m in Figure 80. The circle on the West loosely identifies what in Glasgow is called the west end, and the circle on the East loosely identifies the East End.

6.3.4. Conclusions

The analysis of the Betweenness index on the urban network of Glasgow confirms how the index is able to identify the backbone of the structure of a city, the foreground level which frames our everyday activities in the built environment and allows us to move efficiently across the network.

The analysis of the closeness index conveys a greater insight on local dynamics and has highlighted how Glasgow presents many spatially segregated neighbourhoods.

Post war neighbourhoods such as Drumchapel, Easterhouse, and Castlemilk are not only disconnected from the overall city network as highlighted through the Betweenness centrality index analysis, but also not easy to navigate within their boundaries (Figure 78, Figure 79).

The City Centre presents high levels of closeness @400m throughout (Figure 81), due to its grid iron layout, which is very easy to navigate. The core of the city is disconnected from the west and the east end if we consider the closeness at 400m index, but as soon as we increase the radius to 800 and 1600m (Figure 83, Figure 84) , the city centre, east and west end appear connected. This indicated that east end and the west end can be easily reachable from the city centre through a different form of active travel, cycling, which allows to cover bigger distances than walking.

Glasgow City Council is developing the potential for active travel through the city by encouraging the construction of cycle lanes to connect residential areas to the core of the city through the main gates to the city centre. In particular, the City Centre Strategy (Glasgow Young Scot, 2015) indicates which thoroughfares will be upgraded into “avenues”, streets with a human scale oriented design which will encourage active travel (on foot, cycling). The first of the avenues, Sauchiehall Street, is being currently implemented and forms the basis of one of the case studies contained within this research.

6.4. Commerce and rental values distribution in Glasgow

6.4.1. Location matters

Traditionally in urban geography the concept of centrality is described in terms of attractiveness; a central location is the place where activities want to be located and the competition to find a spot in such location seems to be the ordering principle of the internal geography of cities (Chiaradia et al., 2009).

Research also suggests that historically, urban growth developed in relation to centrality (Mehaffy et al., 2010) following a logic pattern whereby density and activity would intensify around main connections (Jacobs, 1961). As a consequence, areas with greater degrees of centrality are more accessible (Porta et al., 2009), visible and popular and are characterized by the presence of a larger variety of services, a higher land value and a more intensive use of the ground (Wang et al., 2011).

We will investigate the hypothesis that areas associated with higher centrality indexes in Glasgow present a higher presence of commercial activities and services, as well as properties with higher rental values.

Activities can be categorized as primary if their catchment area is larger than local, and as secondary if their catchment area is local (Porta et al., 2011). This research will focus on the presence of secondary activities in their local context.

Cities like Barcelona, Milan, Rome, Parma and Bologna have been analyzed in relation to the variation of centrality indexes and the presence of commerce (Strano et al., 2012)revealing a strong correlation between street centrality and densities of commercial and service activities (Porta et al., 2009).

The intention of this segment of my research is to illustrate that Glasgow is no exception to this finding. Aside from Glasgow City Centre, the highest concentration of secondary retail activities and services tends to align to the high streets of its main Town Centres (Figure 86), confirming that commercial activities tend to concentrate

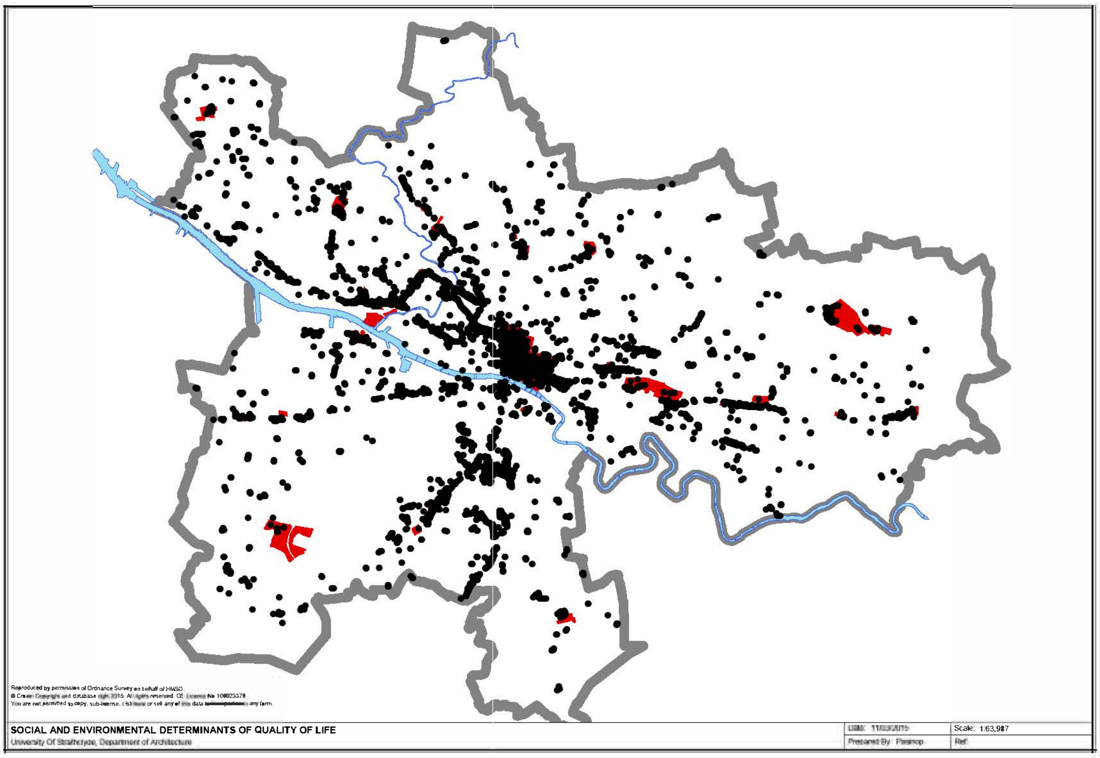


Figure 86. Distribution of retail in Glasgow and Town Centres. Retail units are indicated as black dots, while the town centres are in red.

in areas that benefit from higher centrality as suggested by literature. The distribution of these activities correlates highly with the Betweenness index of the street network, suggesting that a commercial place does not need to be in a location that is a destination in itself to be successful, but that a "pass through" area is structurally just as capable of hosting thriving commercial activities.

The map in Figure 87 clearly illustrates how commercial activities in Glasgow concentrate along axis where Betweenness centrality indexes are higher and those clusters of commercial activities are generally contained within the areas that City Plan 2 defines as Town Centres (Figure 86). The SC 1 - The City's Network of Centres policy contained within City Plan 2 aims to maximize the potential of each Town

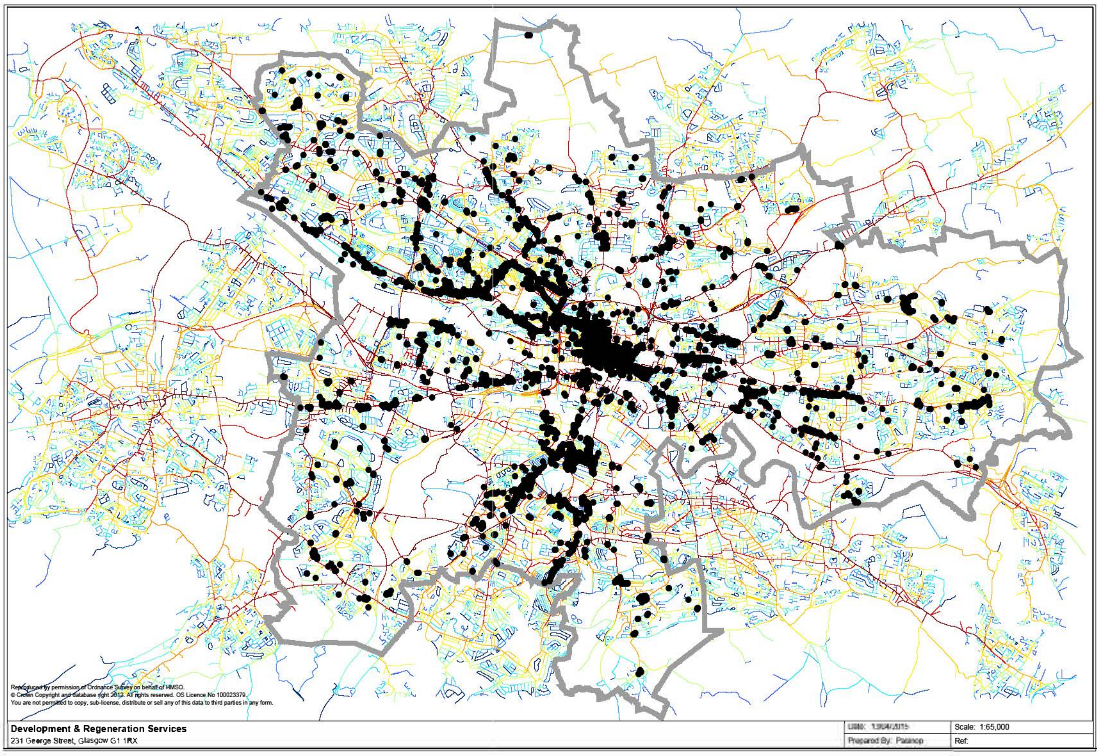


Figure 87. Betweenness Centrality index and retail units distribution in Glasgow's urban network. The correlation between high levels of the Betweenness and presence of commerce is evident even at a visual examination.

Centre in order to enhance its vibrancy and economic sustainability; findings suggest that he higher the Betweenness centrality index, the higher the potential of commercial success of an area.

Designers and policy makers should ensure that the Town Centre's main thoroughfares retain their high levels of Betweenness when addressing traffic or layout issues in the areas.

6.4.2. Study area and data sourcing

The study area covers the area of the network contained within Glasgow City Council's boundary.

Data about commercial properties has been collected by Glasgow City Council and is dated August 2015.

Commercial properties are categorized according to retail typology or vacancy.

The Scottish Assessors Association has provided rental data associated with the commercial properties in 2011.

6.4.3. Methodology

The methodology adopted to investigate whether a statistical correlation can be found between High Levels of Betweenness index and a higher presence of commercial units is based on a Geographical Weighted Regression and is indicated as Kernel Density

Correlation in previous studies (Porta et al., 2009).

As previously discussed, this section will investigate the existence of a correlation between the presence of commercial units and levels of Centrality indexes in Glasgow. The commercial properties (as per August 2015) of Glasgow (point shapefile) and the network of Glasgow (line shapefile) associated with the values of Centrality indexes have been mapped in ArcGIS.

Within the methodology, two different approaches have been developed. The first one follows the steps described in Porta's paper "Correlating street centrality with commerce and service location in cities" (Porta et al., 2009), while the second implements a simplified procedure where the correlation between Kernel densities is computed directly in ArcGIS.

6.4.4. Approach 1

In the first approach, a kernel density with a cell of 50m and a radius of 400m was mapped for the Betweenness Centrality Index and the points of the commercial units layers with ArcGIS (Figure 89, Figure 90). Both kernel densities covered exactly the same territorial extension in order to allow for a cell by cell correlation (Figure 91, Figure 92).

The Raster to Point command in ArcGis produced a new layer containing all the centroids of each raster cell contained in the original kernel densities raster files .

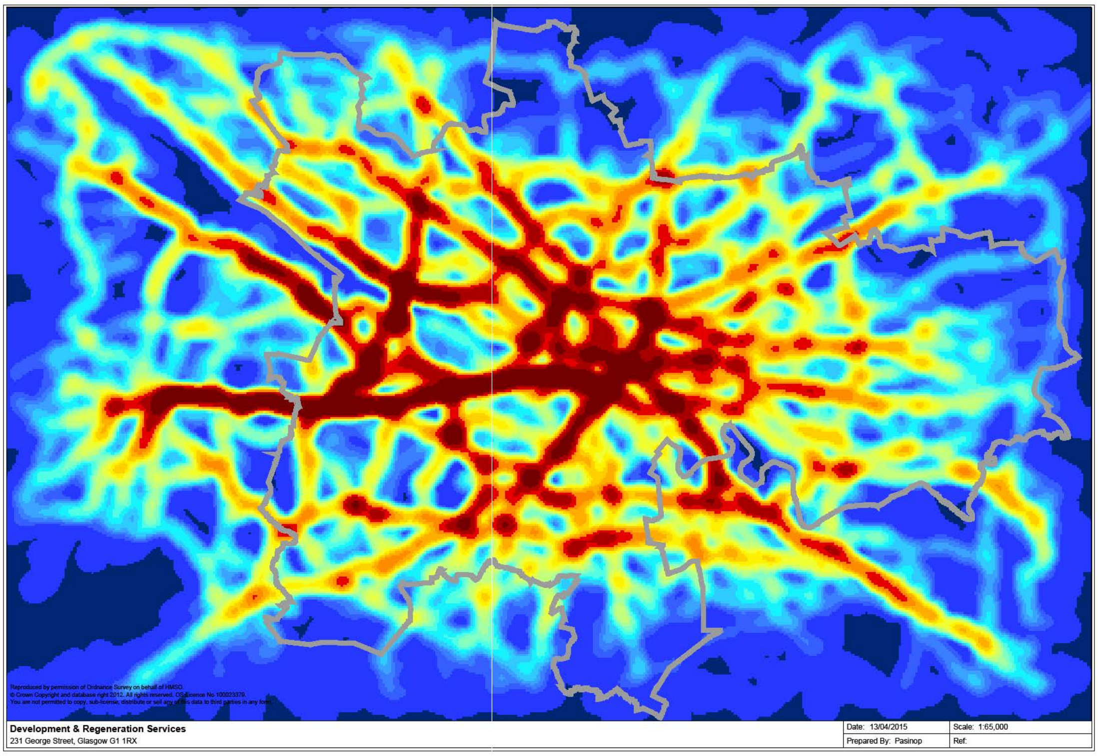


Figure 88. Kernel Density of Betweenness Centrality Index. Glasgow's major thoroughfares are clearly identified by high levels of Betweenness.

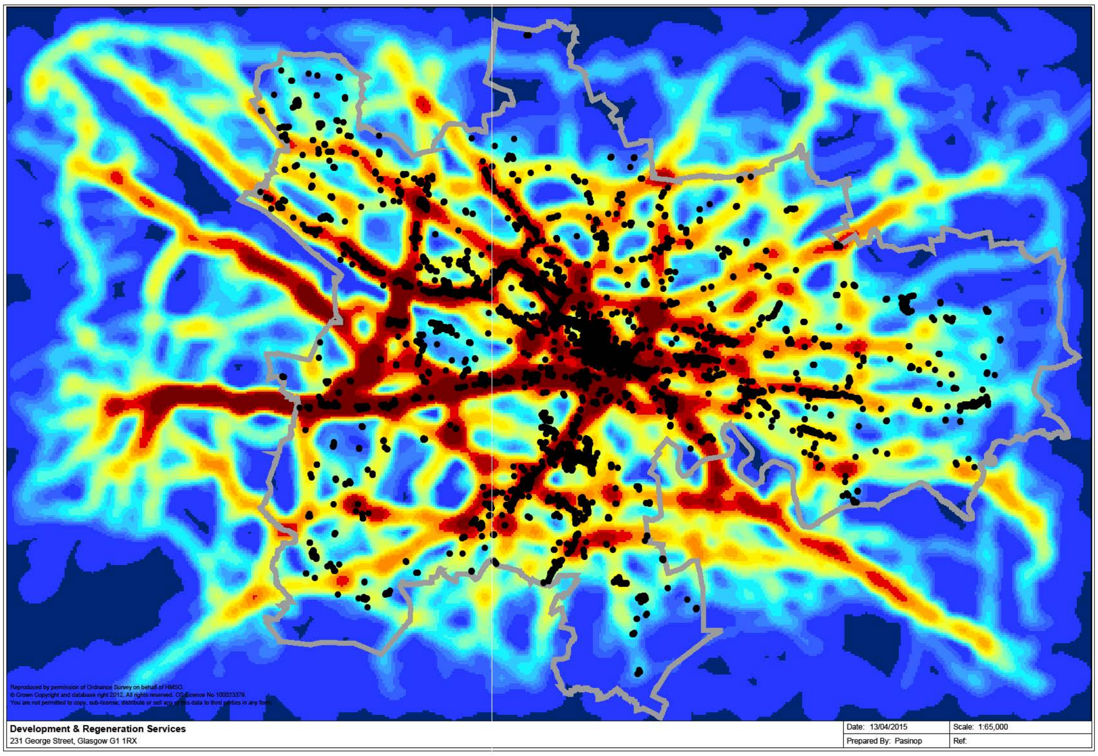


Figure 89. Kernel Density of Betweenness Centrality Index and Commercial Units in Glasgow. The commercial units are mapped as a point file. At a visual examination commercial units are denser where levels of Betweenness index are higher

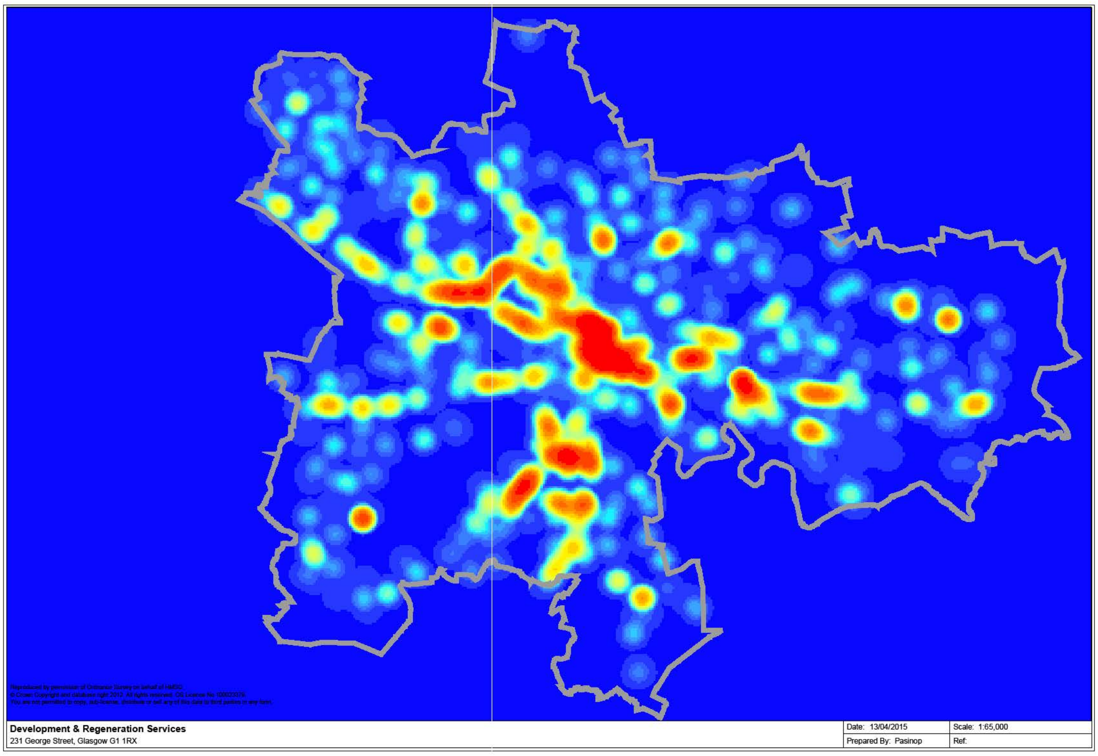


Figure 90. Kernel Density of Commercial Units in Glasgow.

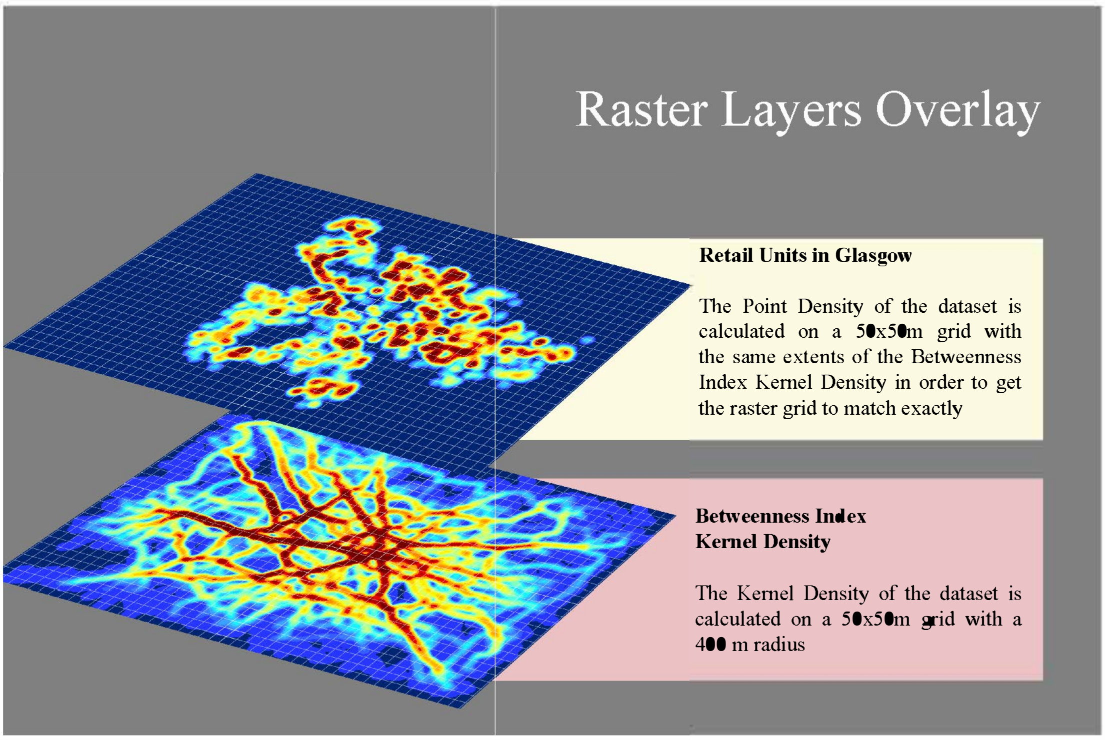


Figure 91. Raster Layers Overlay; the two kernel densities of the commercial units in Glasgow and of the Betweenness index are calculated over exactly the same extent, with a cell size of 50m and a radius of 400m. The raster cells stack exactly oven one another to allow for cell to cell correlation.

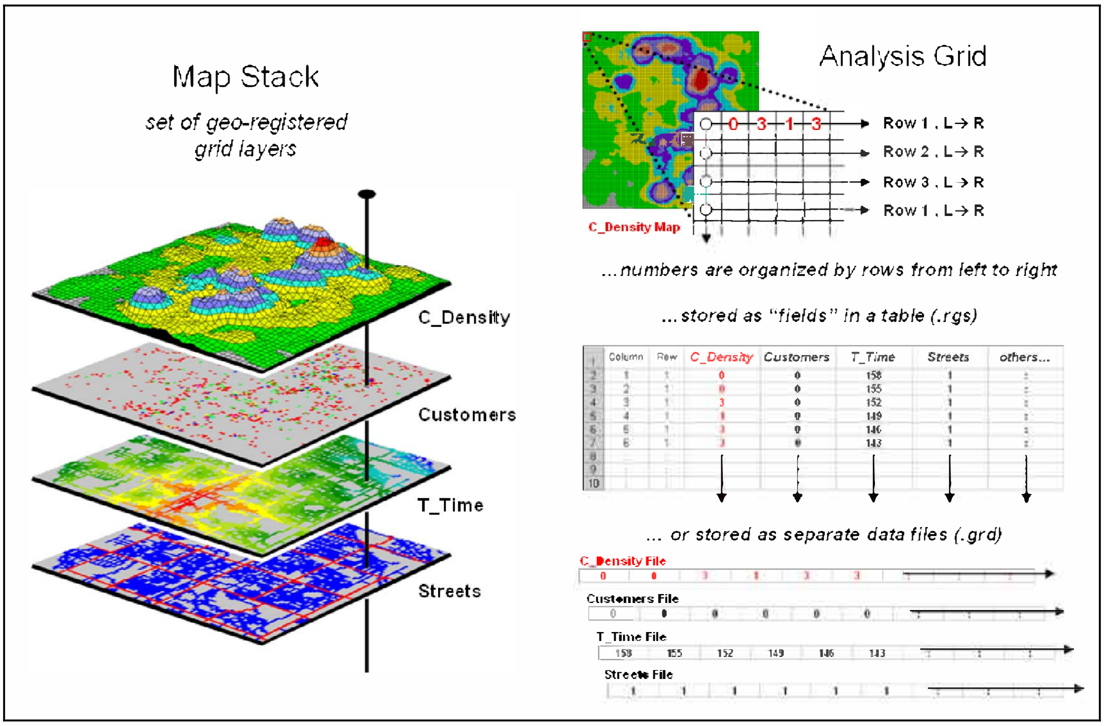


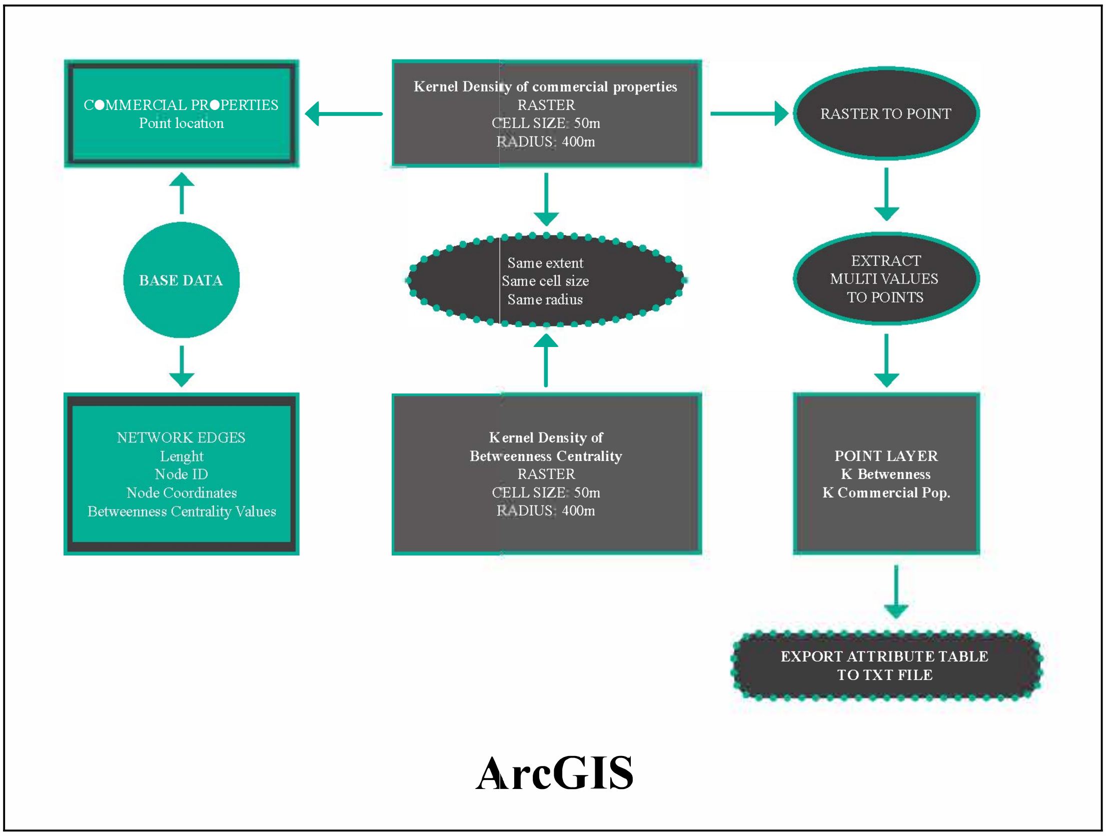
Figure 92. A schematic example of the extraction of all values of the same cell from different Kernel Densities raster layers with the same geographical extent to a correlation table. Through this procedure different datasets coherently georeferenced can be correlated. (Source: http://www.innovativegis.com/basis/mapanalysis/Topic18/Topic18_files/image023.png).

Then each point was assigned the value of each cell from both Kernel Densities through the Extract Multivalues to Points command in ArcGIS 10.

The new GIS layer created through the last step contained the data relative to both Kernel Densities associated to the same point .

The values were available to be exported to calculate possible correlations in excel.

The flow chart in Figure 93 outlines the methodology described with a clear step by step approach.



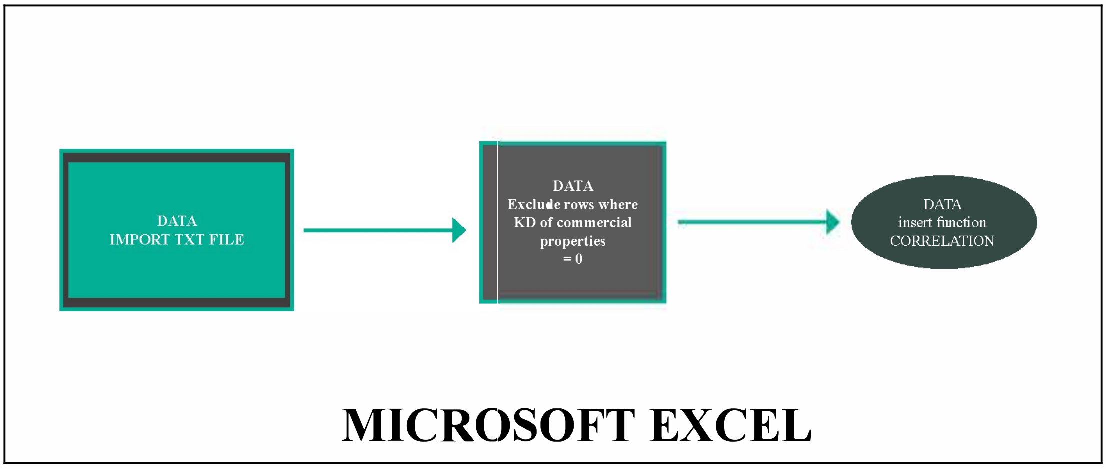
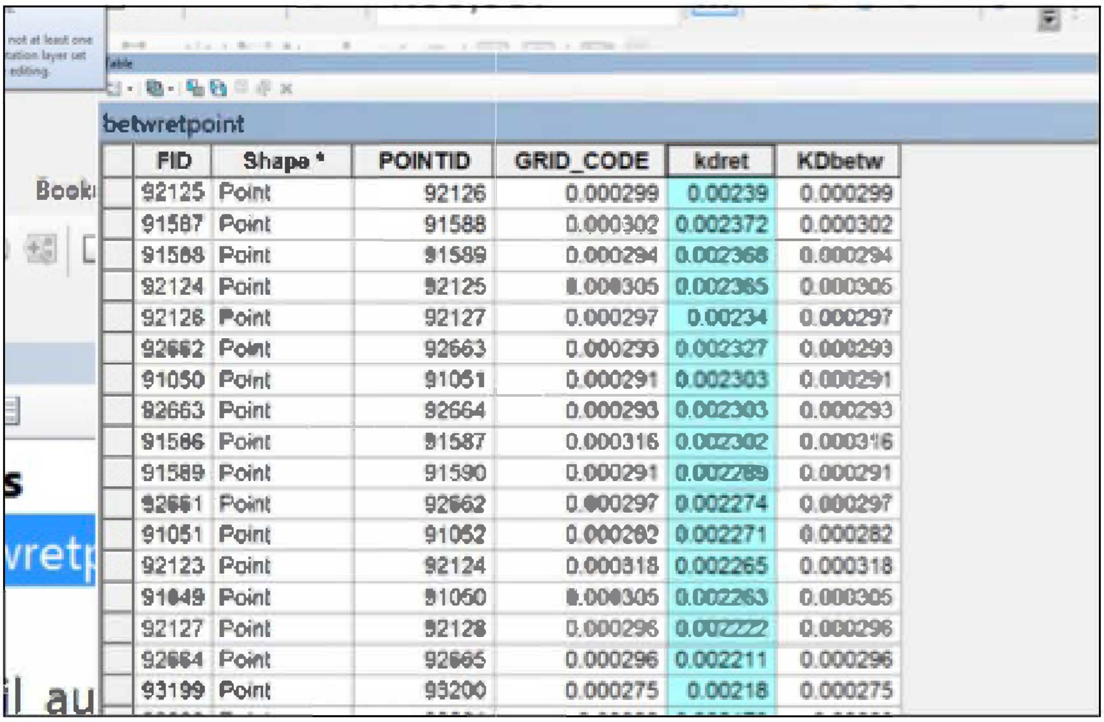


Figure 93. Methodology flow chart. The steps to extract the data for the calculation of the correlation are executed in ArcGIS and then the data is exported to Excel where the calculation of the correlation occurs.

6.4.4.1. Analysis and results

The text file exported from the point file represented in Figure 94 can then be opened in Excel to calculate the correlation between the two variables. The values equal to zero in the Commercial Units Kernel Density are excluded, as if there is not commerce, there is no reason to look for a correlation.

The correlation is then calculated in excel and it produces a coefficient of 0.3609 which indicates that the two variables tent to decrease and increase together, that is as centrality indexes increase or decrease, so does the presence of commerce and services. Results confirm that the Betweenness Centrality index is able to identify areas of the city that are structurally able to support successful commercial activities and services.


betwretpoint

FID	Shape *	POINTID	GRID_CODE	kdret	KDbetw
92125	Point	92126	0.000299	0.00239	0.000299
91587	Point	91588	0.000302	0.002372	0.000302
91588	Point	91589	0.000294	0.002368	0.000294
92124	Point	92125	0.000305	0.002365	0.000305
92126	Point	92127	0.000297	0.00234	0.000297
92662	Point	92663	0.000293	0.002327	0.000293
91050	Point	91051	0.000291	0.002303	0.000291
92663	Point	92664	0.000293	0.002303	0.000293
91586	Point	91587	0.000316	0.002302	0.000316
91589	Point	91590	0.000291	0.002289	0.000291
92661	Point	92662	0.000297	0.002274	0.000297
91051	Point	91052	0.000282	0.002271	0.000282
92123	Point	92124	0.000318	0.002265	0.000318
91049	Point	91050	0.000305	0.002263	0.000305
92127	Point	92128	0.000296	0.002222	0.000296
92664	Point	92665	0.000296	0.002211	0.000296
93199	Point	93200	0.000275	0.00218	0.000275

Figure 94. Screen shot of the attribute table of the new point layer containing all the centroids of the Kernel Densities raster cells associated with the values of the cells of the commercial units Kernel Density (Kdret) and the values of the cells of the Betweenness Index Kernel Density (Kdbetw).

6.4.4.2. Approach 2

Approach two is a simplified version of Approach 1. The correlation coefficient between the Kernel densities of commercial units and Betweenness, Closeness @400, 800, 1600 and Global indexes was calculated in ArcGIS.

For this approach the kernel densities were calculated with a 10m raster cell and with a 400m radius.

The first attempt to calculate the correlation between the raster files following the procedure described in the previous section resulted in dataset which was too large to be handled by excel.

ArcGIS offers the possibility of calculating the correlation between two raster files through the command Band Collection Statistics in Spatial Analyst (http://desktop.arcgis.com/en/desktop/latest/tools/spatial-analyst-toolbox/how-band-collection-statistics-works.htm).

6.4.4.3. Analysis and results

The findings of the simplified approached are summarized in Table 12, where the Pearson's correlation coefficients calculated in ArcGIS have been transcribed.

Table 12. Correlation coefficients between commercial units and centrality indexes Kernel densities calculated in ArcGIS

	Betweenness	**Closeness @400**	**Closeness @800**	**Closeness @1600**	**Closeness Global**
Commerce	0.41094	0.47451	0.48485	0.48852	0.43049

Results indicate that the correlation between the presence of commerce and centrality indexes is significant, that is that the values of the two variables tent to increase and decrease together. The closeness @1600m performs marginally better than the other indicators.

The results emerging from the correlation study on the city of Glasgow confirm the assumption that structural centrality, quantified through the centrality indexes listed in Table 10, plays a key role in the formation and the development of urban structures, clearly driving the emergence of commerce and service areas at the neighborhood level. This result is particularly important for the scope of this thesis, which is striving to unravel the relationship between the built environment and behavior in space; the presence of commercial activities and services is in fact a fundamental requirement for street vitality, co-presence in space and an active public life (Jacobs, 1961).

6.4.4.4. Centrality Indexes and Rateable values

The correlation between centrality indexes and the presence of commercial properties has been established both in literature and in the precedent sections.

This section will explore the possibility of a correlation between centrality indexes and commercial rental values across Glasgow. Data on rental values was not readily accessible; therefore Rateable values have been adopted as a proxy indicator.

The Scottish Assessors Association (SAA) was constituted in 1975 and its principal function is to offer a consistent approach in the administration of the valuation, council tax and electoral registration services.

The SAA provides data on the Rateable Value of commercial properties; the rateable value is derived from the Net Annual value and as the current legislation prescribes, for the majority of properties, Rateable Value and Net Annual Value are the same.

The valuation Roll entry for any commercial property in Scotland can be checked by using the search facility on the SAA or individual Assessors Home Page on their website ((SAA,).

The last evaluation of rates for commercial properties in Scotland was carried out in 2010 and the next one will occur in 2017. The data used in this piece of research has been collected and georeferenced by Glasgow City Council in 2011.

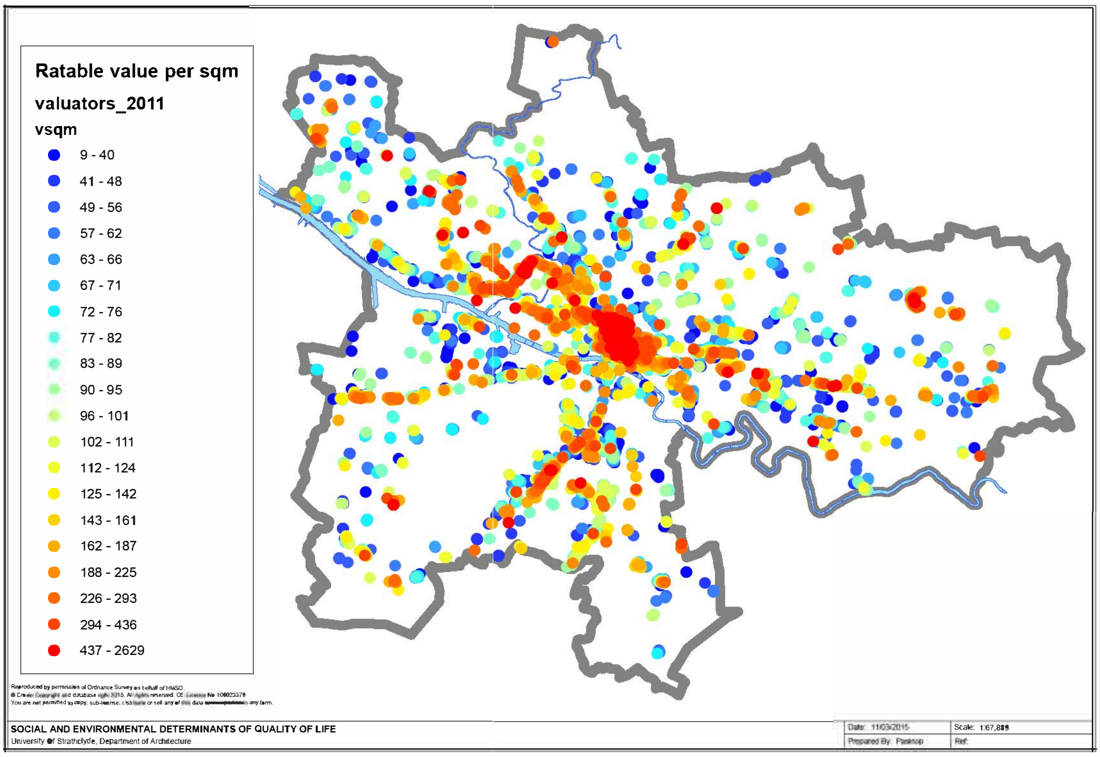


Figure 95. Variation of rateable values per square meter for commercial properties across Glasgow. The raw data presented the overall rateable vale for the property, but in order to offer consistency in the representation of the data, the value was divided by the size in square meters of the property. Rates vary from £9 per sqm to a quite considerable £2629 per sqm a year in the most desirable locations (the higher rate values are concentrated along the Style Mile and Ingram Street in particular).

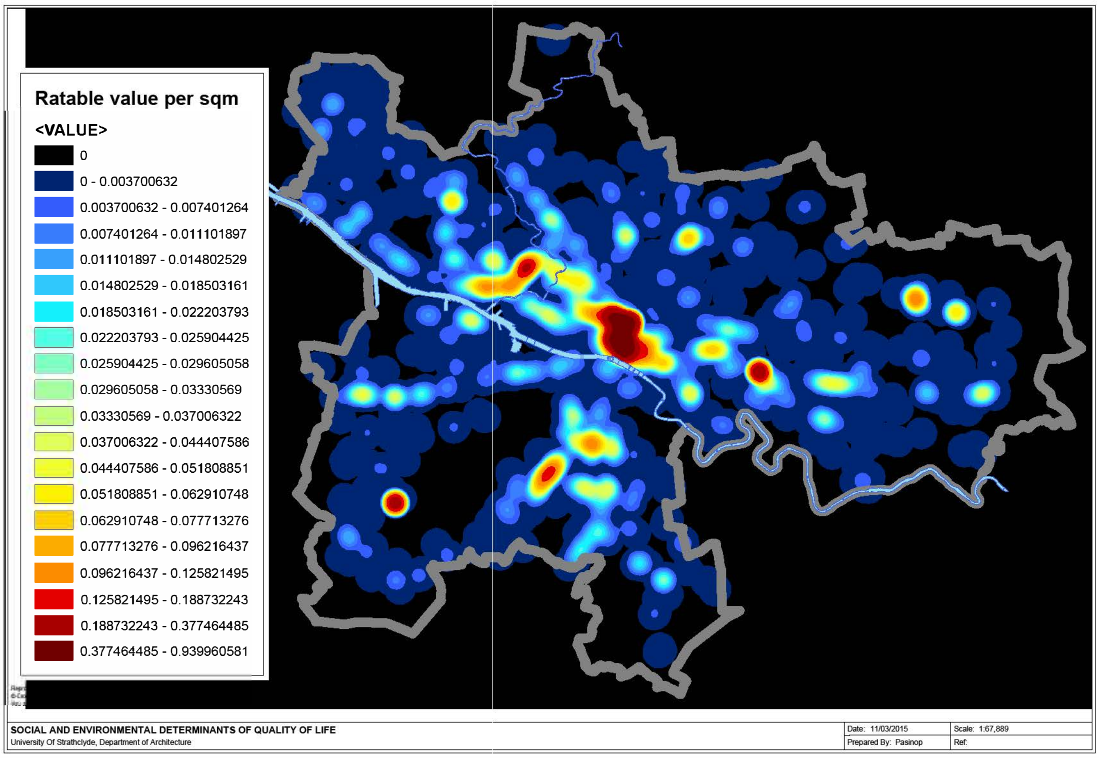


Figure 96. Kernel Density of rateable values per square meters of commercial properties in Glasgow.

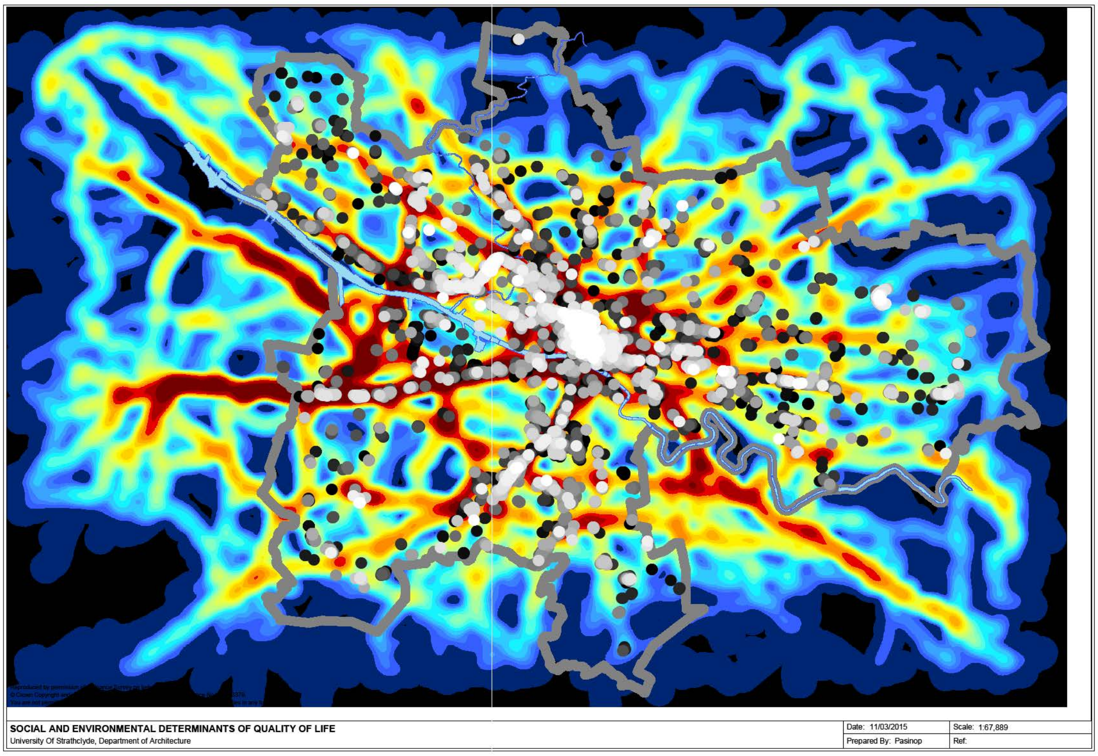


Figure 97. KD of the Betweenness Centrality Index in Glasgow and the variation of the rateable value of commercial properties (Scottish Assessors Association 2011). Rateable values are mapped with a variation from white to black; white units are associated with a higher rateable value. There is a strong relation between these two dimensions, suggesting that where centrality indexes are higher rateable values are also higher.

Figure 97 illustrates that the relation between the variation of the rateable value of commercial properties and the Betweenness centrality index is very strong at a visual examination. Generally in areas where Betweenness centrality indexes are higher (in red), commercial properties are associated with higher rateable values (in white), and vice versa, properties associated with lower rateable values, in gray or black, are located in areas with lower values of Betweenness. The exceptions are purpose built large out of town shopping centres generally located at points of strategic car access from motorways and therefore not following the pattern of an organic city growth.

5.3.3.6 Analysis and Results

The correlation coefficients between the Centrality indexes and the commercial properties Rateable value has been calculated in ArcGIS following the Approach 2 discussed in 7.2.3.3 and are reported in Table 11.

Results indicate that a positive correlation between centrality indexes and Rateable Values exists, albeit not a strong one. The closeness at 1600 is still the best performing centrality indicator; values drop considerably for the Closeness at Global level and the Betweenness Index.

Table 13. Correlation coefficients between rateable value per square meters and centrality indexes calculated in ArcGIS

	Betweenness	**Closeness @400**	**Closeness @800**	**Closeness @1600**	**Closeness Global**
Rateable Value	0.25026	0.34483	0.34828	0.35143	0.27816

Spatial economic theories underpin the idea that spatial accessibility is associated with a generic economic value (Chiaradia et al., 2009) and that rents and land values tend to drop with distance from areas associated with more intensive patterns of land utilization (Casetti, 1967).

Centrality is thus confirmed as an important element in the characterization of urban settlements through the close relationship with the variation of rental values.

6.4.4.5. Case Study: three commercial axis in Glasgow

This section focuses in detail on the relation between street centrality, historic development, retail distribution and rent values in three of the most significant commercial axis in Glasgow City Centre. Whilst all three streets are considered to be the commercial core of the city (City Plan 2 rates them as Tier 1), they display remarkable variations in physical and economic character, and these are discussed in relation to variations of their centrality values.

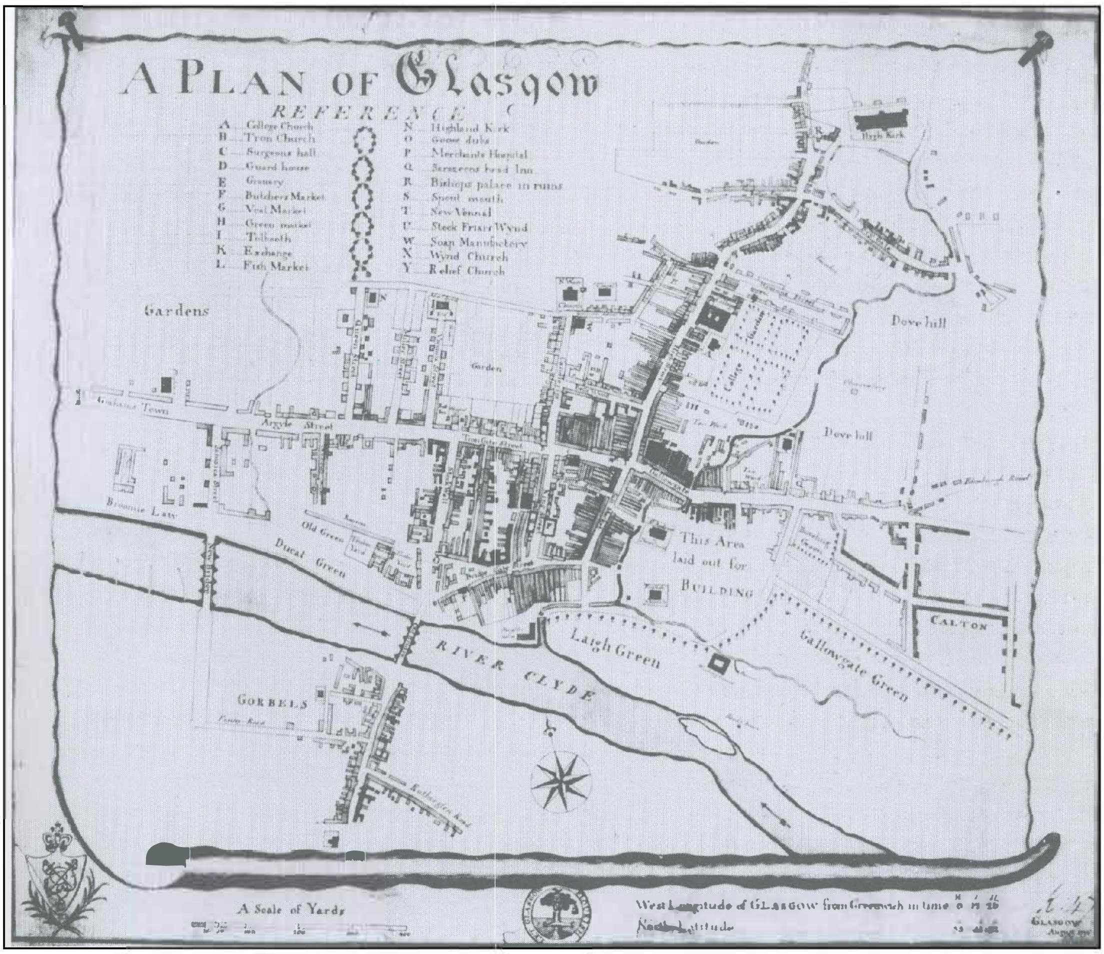


Figure 98. Map of the city of Glasgow in 1776 by R. Collier before the expansion plans commissioned by the municipality. Source : (Reed, 1993)

Sauchiehall Street, Buchanan Street and Argyle Street were designed and constructed when Glasgow was growing rapidly as a trading centre in Georgian times; as a response to the demands for new commercial and residential premises, the municipality commissioned the Surveyor James Barrie a new plan for the expansion of the city towards the West around 1782.

The plan was published in 1776 with an array of new streets based on a simple square grid that, whilst giving no room to topographical considerations, was very efficient in terms of legal and commercial matters (Devine et al., 1995); in this plan, Argyle Street

Figure 99. Plan of the city of Glasgow by the Surveyor James Barry dated 1782; the map show the new expansion plans towards the west; George Square. Source : (Reed, 1993)

was the natural continuation of the Trongate axis E-W, and Buchanan Street a brand new axis N-S to supplement the existing High Street. The new roads and surrounding areas were planned, built and the land encompassed by them divided into plots and put out to the market. The development was thereafter quite slow, likely because of the stringent Building Regulations and the land use limitations imposed by the Council (Gibb, 1983). Glasgow's expansion during the Victorian period saw as main typology the warehouse (Whitehand, 1978) so Argyle, Buchanan and Sauchiehall Streets (that had by then been built in a second wave of expansion towards the North West from Buchanan Street), were flanked with buildings that for the first time were designed for commerce and conferred the retail function that they still retain today (Gordon, 1995).

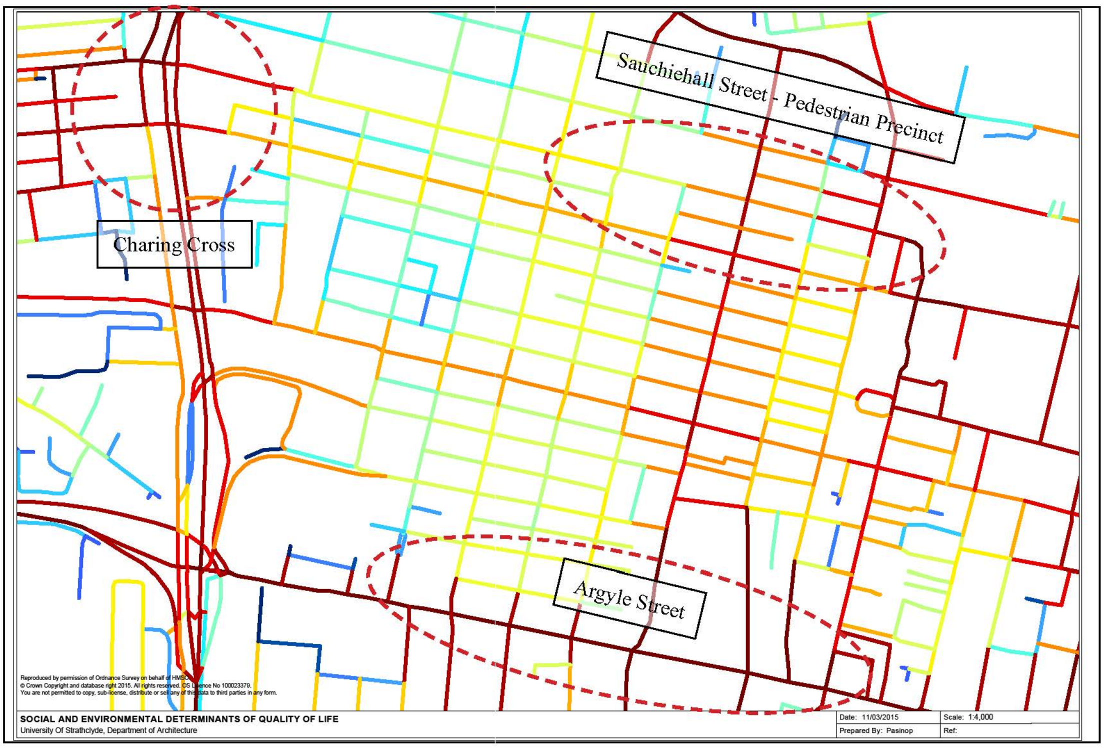


Figure 100. Levels of Betweenness index at the heart of Glasgow's city centre, along Sauchiehall, Buchanan and Argyle Street.

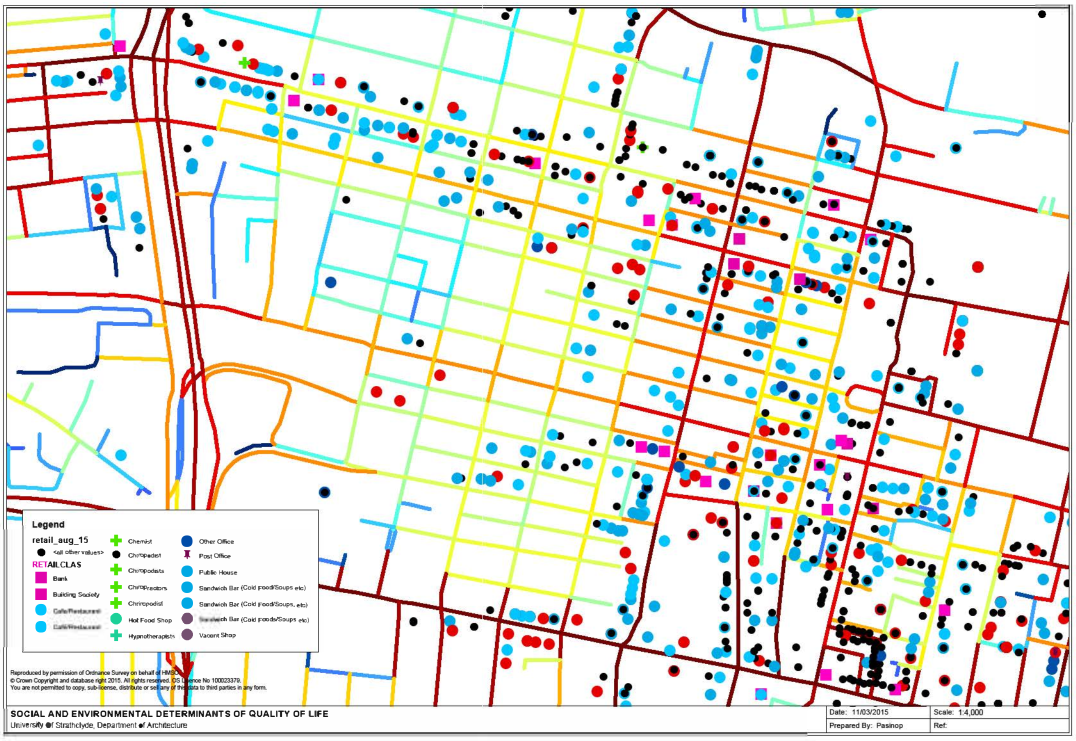


Figure 101. Presence of commerce, food and offices at the ground floor along the three main commercial axis in Glasgow City Centre. Food related premises are indicated with blue dots, vacant units with red dots, health related activities such as doctor surgeries or chemists are indicated with a green cross and offices are mapped with a dark blue dot; any other retail unit is indicated with a black dot.

The Betweenness index (Figure 100) is high along most of the three axes with changes in behavior at observable points. The high-street chains and high-end retail market tend to concentrate along the area with higher levels of Betweenness index, and where the index decreases, the retail offer changes considerably.

The West end of Sauchiehall St is an example; once the pedestrian section ends, the high end retail chains leave space to charity shops, food chains, student bars and small and often not very attractive shops at street level with offices at upper level. The quality and maintenance of the public realm is also lower in correspondence to the lower degrees of Betweenness index (Figure 100).

Incidentally the length of the pedestrian area determined by the Municipality in the 1970 is located in the stretch with higher Betweenness values along the Sauchiehall-Buchanan Street axis; obviously at the time when the decision was taken it would have been impossible to carry out a multiple centrality assessment, but planners must have felt that was structurally the best stretch to be closed to vehicular traffic. After all centrality indexes are able to convey structural characteristics of the built environment which can also be sensed though observation and deep knowledge of how a place functions.

More factors affect this radical change in character of Sauchiehall St, between the pedestrian stretch and the west end stretch, and for sure the highly traffic dominated junction of Charing Cross creates both a physical and a perceived barrier to the west (Figure 102).

Sauchiehall Streets bends south at its Eastern end and becomes Buchanan Street. At

Figure 102. : Sauchiehall Street looking towards Charing Cross: the quality of the shops and the overall environment is poor. Plenty of empty units are dotted along the thoroughfare (Google maps).

the junction between the two Streets are the Buchanan Galleries, Glasgow's main and highest end shopping mall (Figure 103). The two axes at that point present very high levels of Betweenness index; the excellent structural position is for sure one of the reasons behind the great success of the Galleries which will undergo a third phase of expansion starting from 2016.

The whole length of Buchanan Street all the way down to the River Clyde has also received heavy investments from the Municipality, with a new and improved public realm in 1997 and is the shopping heart of Glasgow, a very successful area presenting high levels of Betweenness throughout.

Just two blocks away to the West from Buchanan Street we note that Union Street also presents very high levels of Betweenness centrality as it bridges across the River Clyde; Union Street has not been designated by the municipality as main shopping area and it is one of the main bus routes through the city centre, nevertheless the presence

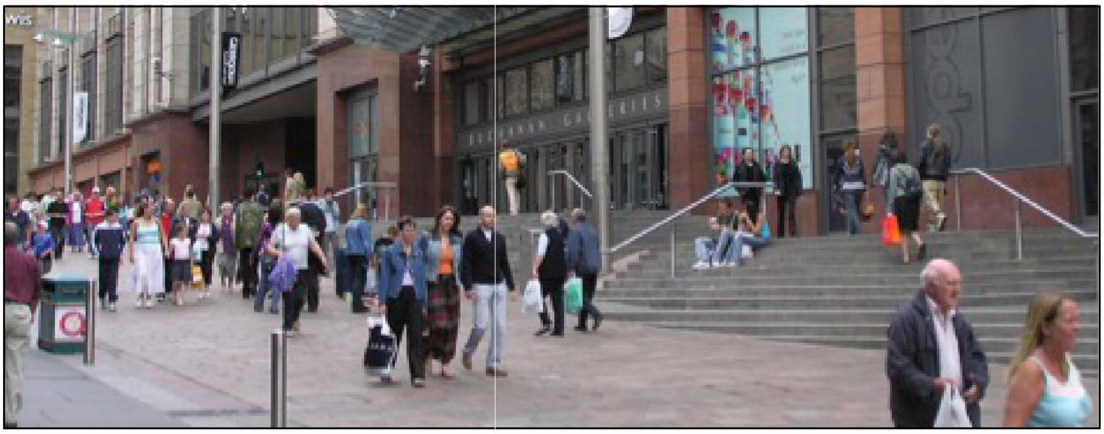


Figure 103. Buchanan Galleries: at the junction between Sauchiehall Street and Buchanan Street at the heart of the pedestrian prescient; the public realm which extends throughout the length of the street and the shops are of very high end quality; an extension to the shopping area is being built at the moment. Rental values are generally at the high end of the spectrum in this area but again, in the stretch of Sauchiehall Street where centrality decreases, rental values also decrease.

of commerce at ground floor level is very dense, reinforcing that, notwithstanding the policy designation, this thoroughfare is structurally able to host successful businesses.

Figure 104. Argyle Street, which runs from East to West and is perpendicular to Buchanan Street also presents very high levels of centrality almost throughout its entire length (more than 3 km in total). A stretch of this long thoroughfare has been closed to the traffic and dedicated to retail. In recent times though, this stretch of the commercial axis, has suffered from the change of retail trends happening around the globe, with on line retail becoming more and more popular. The local retailers association is campaigning for a change of the restrictive retail only planning policy for in this area, in order to permit the opening of restaurants and coffee shops, which would increase the offer for visitors. This aspiration is in line with the recently adopted City Centre Strategy, which envisages a City Centre able to offer more than a retail experience through public spaces able to foster a thriving civic life for all (source: Google maps)

6.4.5. Conclusions

This section of the thesis contains the relationship between street centrality, land use intensity and variation of commercial properties rateable values in Glasgow.

In this study Street Centrality is calculated through the MCA with the adoption of the measures of Betweenness and Closeness Centrality.

Land use intensity is measured through the presence of ground floor commercial and service activities; the variation of rateable value is indicated per square meter of each commercial property as per the data provided by the Scottish Assessors Association.

Results indicate that retail and services, as well as higher rateable values, tent to concentrate in areas, which benefit from higher values of centrality indexes.

Results have been evaluated visually and then supported through the results of a simple correlation analysis.

The study also supports the hypothesis that the MCA model is an effective tool to map the variation of centrality indexes and can provide a useful guide to designers and policy makers with the capability of highlighting areas presenting a "location advantage" across the urban network (Porta et al., 2007).

6.5. Methadone prescriptions as a proxy indicator of deprivation in Glasgow

In the previous sections discussed how livelihood is an important element for successful public spaces, where thriving public life and co presence in space can be fostered.

But what happens when public spaces are not lively, when the urban form is not conducive to thriving public life but to poor social outcomes?

At the end of the 19th century Charles Booth's undertook a survey of the social and economic conditions of the population of London; the study contained the Descriptive Map of London Poverty, which a part from defining and identifying social classes for the first time in the history of social sciences, located them spatially on a street by street basis through tables, charts and color coded maps (Vaughan et al., 2005).

The spatial patterns of poverty identified in Booth's work still persist in today's London (Orford et al., 2002) notwithstanding the improvement of the general conditions of living; the link between physical segregation and economic marginalization, often defined as urban poverty, is a difficult one to break.

Configurational theories, methods, and tools like Space Syntax or the MCA, are able to contribute to a more nuanced description of spatial and social relations on both a local and a comprehensive level and have the ability to shed light on important differences at different scales, whether it is at street level, or at city or metropolitan level; unfortunately such practices have not as yet been included as normal procedure, as a necessary element in the gathering of evidence necessary to support planning and urban design decisions.

Theories that link physical and spatial forms to social outcomes in real space, such as Space Syntax and the Multiple Centrality Analysis MCA, allow the creations of models able to predict the outcomes of changes in the urban structure of complex urban structures, as demonstrated through the examples in the Betweenness index section in the case of Govan.

The key objective of this section is the exploration of social segregation, and in particular of the relationship between social malaise, or poor social outcomes and space configuration; such relationship will be examined through the analysis of distribution of centrality indexes calculated through the MCA in Glasgow, Scotland, and the occurrence of methadone prescriptions, adopted as a proxy indicator of deprivation.

The choice of using Methadone prescriptions as a proxy indicator for deprivation is supported by multiple reasons:

1. Data Availability. It is very hard to access sensitive data, such as information on issues relative to deprivation, at address level. Scottish Government tracks issues of deprivation across the nation through the Scottish Index of Multiple Deprivation (SIMD). The geometry of the index is based on Scotland's datazones, which are groups of 2001 Census output areas which include a

population of between 500 and a 1000 households. Such geometry has by far too big a scale to be significant in urban morphology studies, where urban morphology indicators are associated to streets and not to large areas. Address based data on Methadone prescription is collected jointly by the department Social Work in Glasgow City Council and the NHS.

2. Literature background. Since the 1900s, UK governments focused their resources in the fight against drugs in local communities and problem areas across the country. This was a reflection of the awareness that drug related problems concentrated in deprived areas affected by social and spatial segregation(MacGregor et al., 2011). Julian Buchanan, Stevens, Trace, and Bewley Taylor all ink crime and drug consumption to social deprivation, and in particular with the declining job opportunities for the unskilled, non academic, young people who reside in disaffected and isolated communities ((Buchanan, 2006). Anand and Sen indicate that drug addiction is one of the driving factors behind the breakdown of the traditional social structure of society and it can be adopted as a proxy indicator to measure the relational aspects of social exclusion (Anand et al., 1994).

3. The Glasgow effect. In Glasgow almost half of the deaths under 65 years olds is related to drugs or alcohol abuse (Steven et al., 1996); with similar levels of deprivation to Liverpool and Manchester, premature deaths in Glasgow are

30% higher, but the reason behind this phenomena remain unclear (Walsh et al., 2010). Could urban form have a role in the equation?

The analysis links existing health data (collected by the NHS) to urban morphology data developed through the calculation of centrality indexes across the urban network of Glasgow; this section will also discuss the challenges in retrieving the data on Methadone Prescriptions, and the evolution in the approach of data sharing for research development by governmental organizations in the past few years.

Often configurational theories associate deprivation with social segregation and spatial exclusion (Vaughan et al., 2005).

The concept of Social Segregation was originally developed by French sociologists who referred to the phenomena of "social disqualification" (Paugam, 1995) resulting in the breakdown of the relationship between the individual and society. According to the European Commission each citizen is entitled to a certain standard of living and to participate to the basic institutions of society such as employment, health care, housing, etc. When citizens are not able to access basic social rights we talk about social segregation or exclusion, a complex and multifaceted concept, which refers to individuals and society alike, to alienation and loss of freedom.

The spatial dimension of social segregation is explored in relation to the role played by space configuration; social segregation is often equated to spatial segregation, an inherited phenomena in urban settlements which historically reoccurs and redistributes itself further to changes in the makeup of the population (Vaughan et al., 2011).

Marcus and Vaughan both claim that segregation has intrinsic spatial implications – segregated/separated from where - and that space configuration has to be considered as one of the fundamental factors behind the phenomena (Marcus, 2007).

The following section will investigate the relationship between space configuration and the distribution of methadone prescriptions, adopted as a proxy indicator of deprivation, in Glasgow.

6.5.1. Glasgow: Study area and data sourcing

The area covered by the study lies within Glasgow's political boundary. The extent of the urban network and its characteristics has already been discussed in the previous sections.

The data relative to the Methadone prescription is co-owned by the department of Social Work at Glasgow City Council and the National Health Service (NHS). The data is dated 2013.

Accessing the data was not straightforward. We started inquiring about the data at the department of Social Work as we thought that, as a City Council Employee, we would be granted full access to the information.

That was not the case. After completing a lengthy form (GCC Social Work Ethical Disclaim) to request access to the data by explaining the research plan, and being approved by Social Work, it became apparent that the NHS also had a saying on whether the data could be accessed or not, and that their disclosure procedures would also have to be entertained.

The NHS disclosure procedure involved obtain an Ethical disclosure from University of Strathclyde, that aside from the amount of form filling that I had to endure, was granted without major complications.

To grant access to the data, the NHS required that the research plan received an approval from the West of Scotland Ethical Committee through a REC application and a hearing in front of the ethical committee (Caldicott Approval). Notwithstanding the fact that it was the first time that an Architect stood in front of the commission, the research plan was approved and deemed worthy of accessing the data.

But when it came to agree a methodology on how to access the data, the NHS pulled away on the basis of patient confidentiality and possible breach of anonymity.

It was clear that the person that had the last word on my research did not have a grasp of what I was proposing and stood on the side of caution.

The final breakthrough that allowed access to the methadone prescriptions data happened thanks to The Scottish Health Informatics Program (SHIP).

SHIP was a Scotland-wide research platform for the collection, administration, diffusion of Electronic Patient Records, and building on Scotland's established history of linkage research. This specific research program has now terminated but the knowledge, infrastructure and cross-sectorial collaborations are being brought forward by the Farr Institute @ Scotland.

In June 2013 SHIP opened the first Safe Haven in Glasgow developed within NHS Greater Glasgow and Clyde, in partnership with the Robertson Centre for Biostatistics to provide access to linked datasets to facilitate the employment of clinical data for research.

The Safe Haven allowed access to a predefined set of datasets, like GP data, prescribing data (Methadone prescriptions included), etc.

One of the main objectives of the Safe Haven is to be able to share data securely and protect patient confidentiality; this was achieved through a robust governance structure and the institution of a Local Privacy Advisor Committee.

In practical terms, working with the data was very straightforward. After illustrating the research methodology and agreeing which datasets were required, a two hours slot in the safe haven was agreed. A Safe Haven is a room with a computer that does not have any external links, no Internet connection, and no USBs ports. The agreed datasets and requested software (ArcGIS) were preloaded in the computer by the staff, and we could work on the data and produce a complete anonymized output.

The output was then approved by the staff and emailed a few days later.

We worked for longer than a year to access the Methadone Prescription data and we were granted access to it when a complete change in culture towards data sharing happened in the NHS.

We were the first users of the Safe Haven in Glasgow, where we developed a solid knowledge on how to handle and share data securely, protect anonymity and encourage lined data research.

6.5.2. Analysis and Results

Notwithstanding the overall final approval of the research methodology, we were granted access to the Methadone prescriptions data in Glasgow only at postcode level (Figure 105), rather than at full address level, and this proved insufficient to allow the development a full correlation analysis between the spatial distribution of Methadone

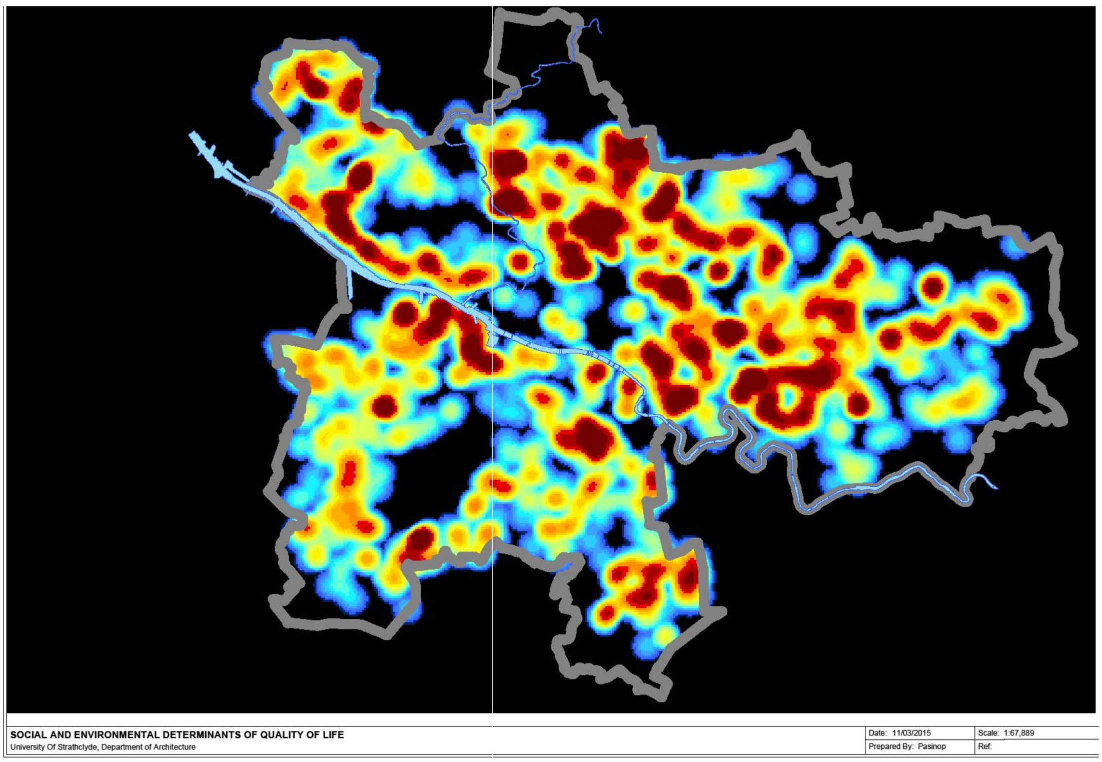


Figure 105. Kernel Density of the distribution of methadone prescriptions in Glasgow in 2011 calculated with a 50m cell and a 400m radius; the point data was aggregated to postcode unit geometry rather than punctual at local addresses.

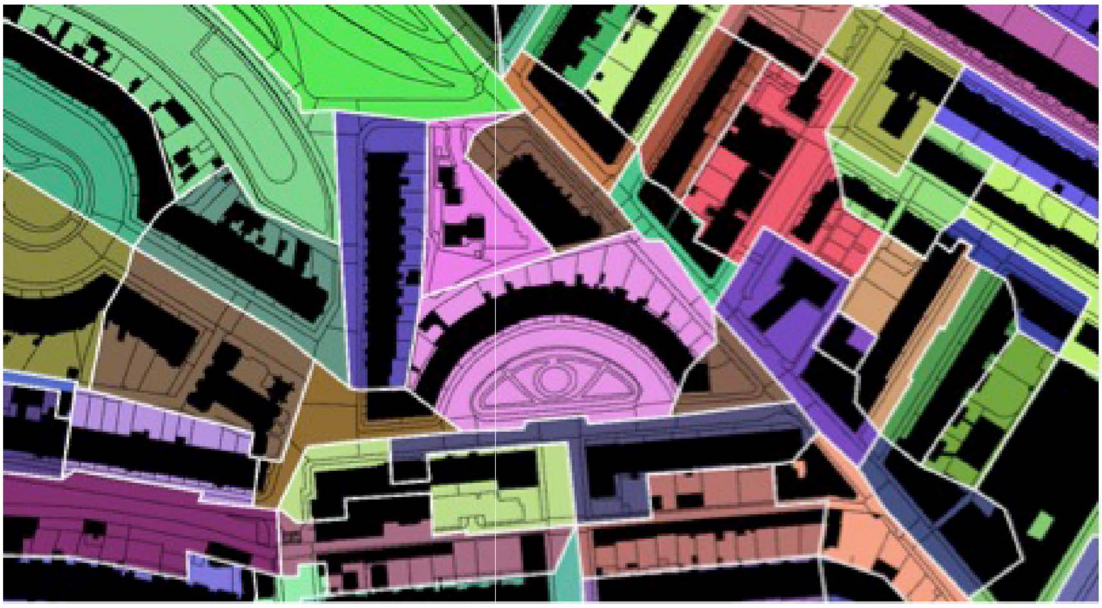


Figure 106. Detail of post codes geometry in an area of Glasgow's West End. The postcode geometry is not associated with a street, or a building, but with the number of postal addresses it contains. It is not a homogeneous unit, which can be adopted for correlation with Centrality indexes, as the occurrence of methadone prescriptions is associated with the centroid of the postcode geometry, rather than being located in an actual street.

prescriptions and centrality indexes.

The attitude towards sharing medical data for research has changed so much even from the beginning of this research that quite possibly, if we had to start the process again today, we would be granted full access to the data; this could be a starting point for further research into the link between medical data and urban form.

6.5.3. Conclusions

This section of the thesis examined the relationship between street centrality and the occurrence of methadone prescriptions.

Unfortunately, due to data unavailability, a full correlation analysis between centrality indexes and occurrence of methadone prescription has not been developed.

The hypothesis of the existence of a correlation between low levels of centrality indexes and high numbers of methadone prescriptions remains to be proven, and could constitute the basis for further research.

6.6. Post war housing developments in Glasgow

The cityscape of Glasgow outwith its historical core is largely characterized by post wars developments designed through modernists and neighbourhood planning theories; such neighbourhoods, which are present throughout Scotland an the UK, display quite different preconditions for sociability compared to areas with a more traditional urban character (Bianchini, 1990) and are often the areas that host high levels of deprivation. Towards the second half of the 20th century it became apparent that the many ambitious social housing schemes were rapidly declining, and the physical and spatial form of these areas was pointed out as one of the possible reasons behind the poor social outcomes of these localities (Hillier, 2002).

In the UK, a substantial amount of the disadvantaged live in cities, large areas of which have been economically and socially affected by the effects of the deindustrialization, and ineffective urban policies (Macintyre et al., 2008).

Glasgow, as other old industrial cities, has been greatly affected by market-led urban policies, which have been unable to address the real problems at the heart of a community that was no longer at the centre of an active labour market (Pacione, 1993). By 1981 the major areas of deprivation in Glasgow were concentrated in the four large peripheral housing estates of Drumchapel, Castlemilk, Easterhouse and Pollock, while only ten years earlier a much larger proportion of deprived areas were located in the city centre (Figure 107) (Pacione, 1993).

During those 10 years the local authority had implemented a large program of clearance and redevelopment of the traditional inner tenement housing areas, together with some modernization of the tenements and new buildings by housing associations and by 1981 the inner areas were inhabited by an ageing population living in improved accommodations, while the new estates were populated by a much younger demographic; overcrowding and unemployment were widespread together with a high proportion of single-parent families. Deprivation had become concentrated in the

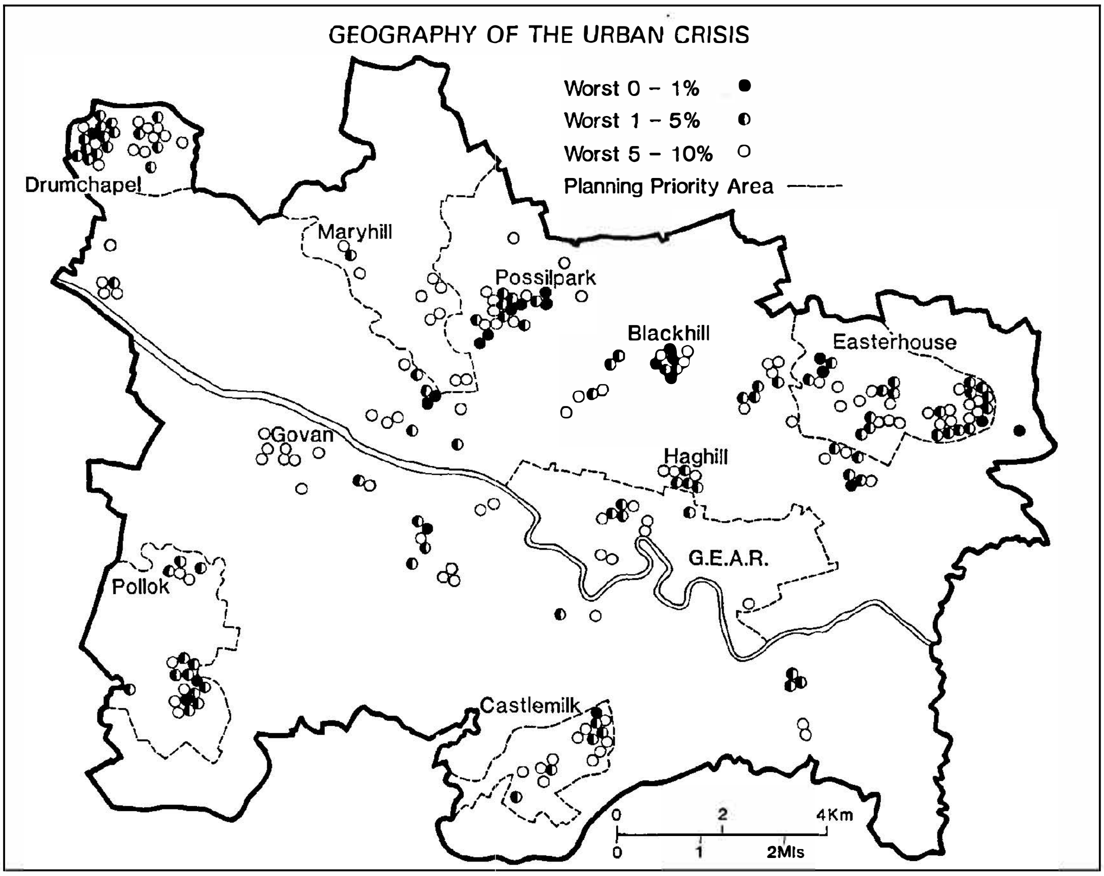


Figure 107. Multiple deprivation in Glasgow, 1981 (Pacione, 1993).

public sector housing schemes in a matter of a decade.

In 2012 the situation remains largely unchanged (Figure 108) and the post war peripheral housing estates remain within the worst deprived areas in Scotland.

What are the causes of social segregation in cities, and why patterns of segregation and exclusion cluster in urban environments? And why are those clusters resilient in time? The importance of urban form in influencing social outcomes, an in particular the relationship between urban morphology and the spatialisation of poverty, is at the core of the study described in this section.

Contemporary studies of poverty rarely take into consideration the impact of space on people's lives; Lupton, an isolated exception, reports that the physical characteristics

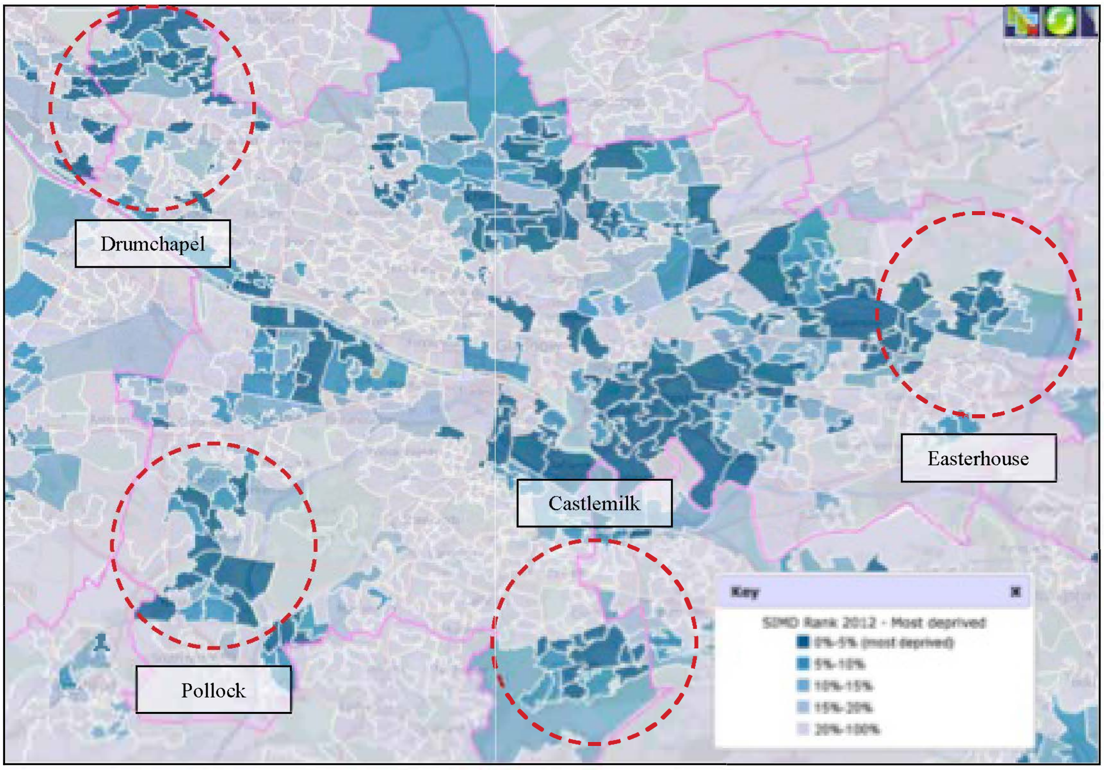


Figure 108. 2012 Scottish Index of Multiple Deprivation (http://www.sns.gov.uk/Simd/Simd.aspx). Glasgow's post war developments remain in the most deprived areas in Scotland.

of the built environment, through their impact on population mix, can influence the reputation, social order, patterns of social interaction in neighborhoods, as people and space interact.

Disadvantaged individuals may form different relationships according to the space they live in, whether it is an isolated or well-connected area (Lupton, 2003).

Ellaway investigates areas effects on individual outcomes and adds that the area of residence is linked to levels of obesity and physical activity (Ellaway et al., 2005).

Research conducted through spatial configurational theories seeks to relate socio economic outcomes to the physical characteristics of the built environment, and in this particular case, to the configuration of space in the built environment.

Laura Vaughan in her paper about the spatial distribution of poverty in 19th century London, reveals the existence of a strong correlation between poverty and spatial segregation, and on the other hand, between prosperity and spatial integration.

This segment of research will investigate the spatial configuration of four post war developments in Glasgow: Easterhouse, Castlemilk, Drumchapel and Pollock; thanks to the SIMD 2012, which indicates that those areas fall in the 5% most deprived areas in Scotland, and have for some time, we are aware of the poor social outcomes of these areas.

Whilst the SIMD is a powerful tool able to indicate at a large scale where problem areas are located, there is a requirement for the implementation of policies that focus on urban design and planning rather than on housing. Scottish Government is moving in the right direction through the Designing Places and Designing Streets policies, which acknowledge the requirement of human scale environment to ensure positive social outcomes.

6.6.1. Study area and data sourcing

The study areas are the four post war developments of Castlemilk, Drumchapel, Easterhouse and Pollock. Analysis will be carried out on the whole urban network and not only on the portions contained in the areas boundaries, one to avoid any possibility of "edge effect", and two as we are considering these areas and their behaviour in terms of centrality indexes with respect to the whole city and not just within their boundaries. The boundaries of the post war outer estates are to be considered as indicative, as Glasgow City Council has not issued statutory boundaries for these neighbourhoods. As such, the boundaries illustrated in Figure 109, Figure 110, Figure 111, Figure 112, Figure 113 are to be considered indicative; the boundaries for Drumchapel, Pollock and Castlemilk are based on Michael Pacione's map in Figure 107, while the boundary for Easterhouse has been traced by an artist according to the perceptions of the local residents, and is much smaller than the one indicated by Pacione, which also included the land dedicated to park and green.

Figure 109. : *Drumchapel is located in the northwest area of the city boundary; it was developed in the 1950s and 1960s as apart of the program to relocate the population displaced from by the inner city comprehensive development programs. At its peak, in 1971, it house 34.000 people; population has since then considerably declined. Large areas of derelict land are a consequence of the demolition of substandard council housing (Pacione, 1993). Scale 1:10.000 @A3*

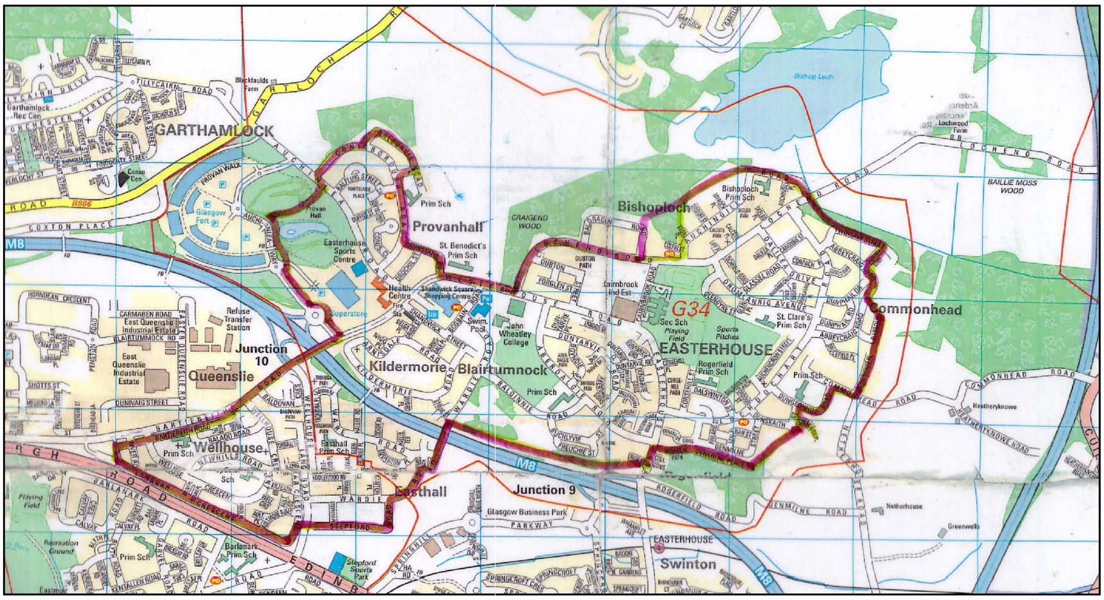


Figure 110. *"One of the strange things about Easterhouse, with its huge reputation, is that it is nowhere defined on a map. Greater Easterhouse appears, a district of relevance to the Glasgow City Council elections, but this includes a much larger area with other districts. It felt wrong that a place of such history and belonging should not be located on maps or on the ground. With the help of Pauls Marsden from Platform Arts who helped with pen and map, and with an enormous quantity of wool I set about putting this right. I walked the entire perimeter of Easterhouse, where the city meets the country, the motorway, the edge, and as I walked I laid down one continuous line of brightly colored wools, thus defining the area enclosed within. A distance of 10.6kms, the walk was performed on 5th February 2013. I saw deer, icicles, wildlife, birds and buses, and lots of people." Carrie Gooch (https://carriegooch.wordpress.com/2013/04/02/easterhouse-wrap/)*

Figure 111. *Easterhouse is the largest peripheral post war development in Glasgow. The housing estate consists primarily of three and four storey tenements inhabited mainly from the population moved out from the old tenements in the East End. As indicated by the SIMD the area presents poor social outcomes (Pacione, 1993). Scale 1:10.000 @A3*

Figure 112. *Castlemilk was also developed between the 1950s and 1960s as a council scheme for the population cleared from inner city slums. Notwithstanding the designation of the area as a Social Inclusion Partnership Area in 1988, and the substantial investments in housing renewal, the area remains in the worst 5% most deprived areas in Scotland according to the SIMD 2012. Scale 1:10.000 @A3*

Figure 113. Pollock is located in the southwest edge of the city. This estate was developed in different phases from the 1920s, but the post war period saw the most of the construction, with a large number of houses being built to host the population from the inner city slum clearances. Pollock was one of the first outer developments in the city to attract private investments and it accommodates more than 4000 private homes. The SIMD 2012 (Figure 106) indicates that levels of deprivation are lower in this estate; please note that the areas covered by the Pollock development is much larger than Easterhouse, Drumchapel or Castlemilk. Scale 1:25.000 @A3

6.6.2. Methodology

The key objective for this analysis is to evaluate the performance of the urban structure of Glasgow's post war outer estates against the Centrality indicators calculated through the MCA.

Most research on social segregation stems from sociology, and it is commonly based on descriptive statistics of socio-economic data.

Mainly different urban areas are characterized through their social constitution depicted through indicators like income, education, health, education, etc. From such indicators different urban areas are associated with different social outcomes and indicated as deprived, like in the case of the SIMD.

In the case of this research though, the point of departure is space itself and human behaviour in space.

Traditional geographical units, like datazones in the case of the SIMD, are often too crude to allow for a detailed analysis of what happens in the real city, the micro-scale of human behaviour.

The analysis of centrality indicators presents the possibility to study deprivation at a more detailed level, with a theoretical background in architecture and urban morphology, to really understand how people are connected through public spaces, rather than averaged through statistic indicators, and to present more effective actions to remedy the status quo though the built environment.

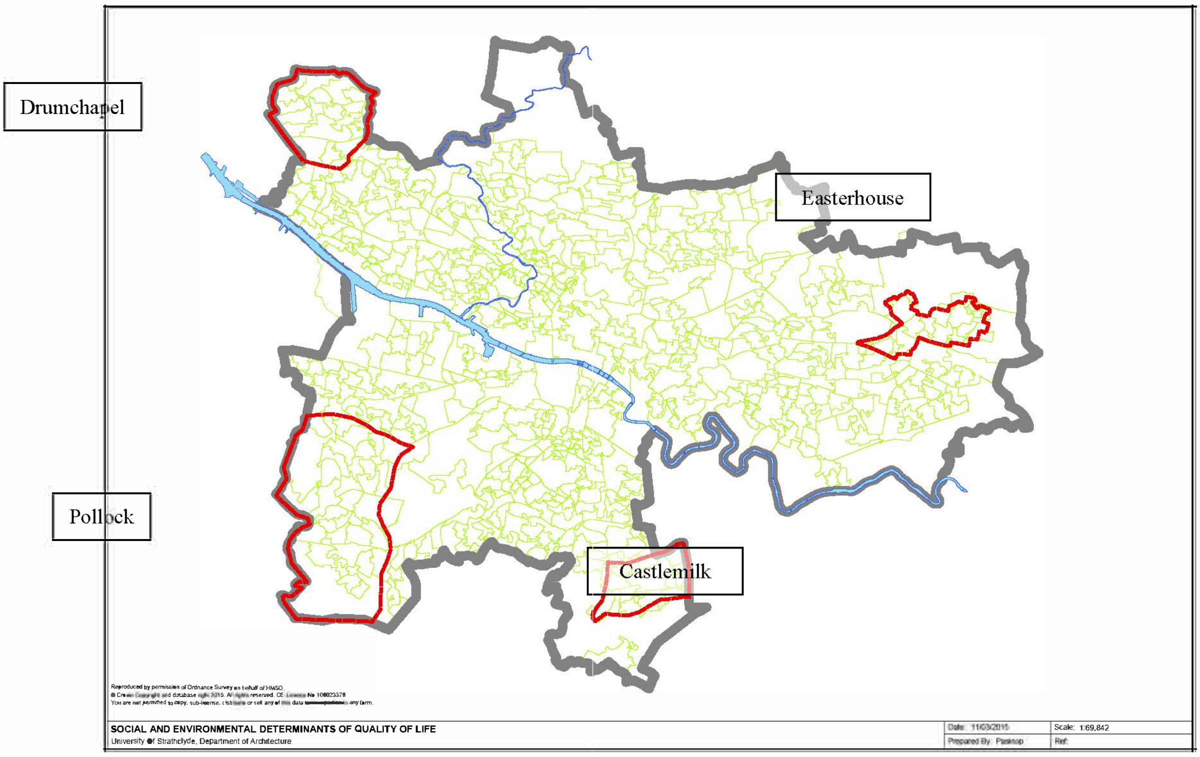


Figure 114. : There are 693 Datazones in Glasgow; The Scottish Neighbourhood Statistics Guide defines them as: "The data zone is the key small-area statistical geography in Scotland. SNS has introduced, for the first time, a common, stable and consistent, small-area geography called data zones. The data-zone geography covers the whole of Scotland and nests within local authority boundaries. Data zones are groups of 2001 Census output areas and have populations of between 500 and 1,000 household residents. Where possible, they have been made to respect physical boundaries and natural communities. They have a regular shape and, as far as possible, contain households with similar social characteristics." (http://www.gov.scot/Publications/2005/02/20697/52626).

6.6.3. Analysis and results

As discussed in 5.4.2, Mehaffy et al report that in most cases post war developments have been designed with a Shielded Nucleus approach; the urban nucleus, where activities are situated, is located at the centre of the neighbourhood in a calm area detached from thoroughfares, which surround it but do not traverse it (Figure 116) (Mehaffy et al., 2010).

This approach results in a separation of the local community level from the city wide level; this often results in segregated communities where passing though traffic is absent, and so is the possibility of interaction and public spaces between different

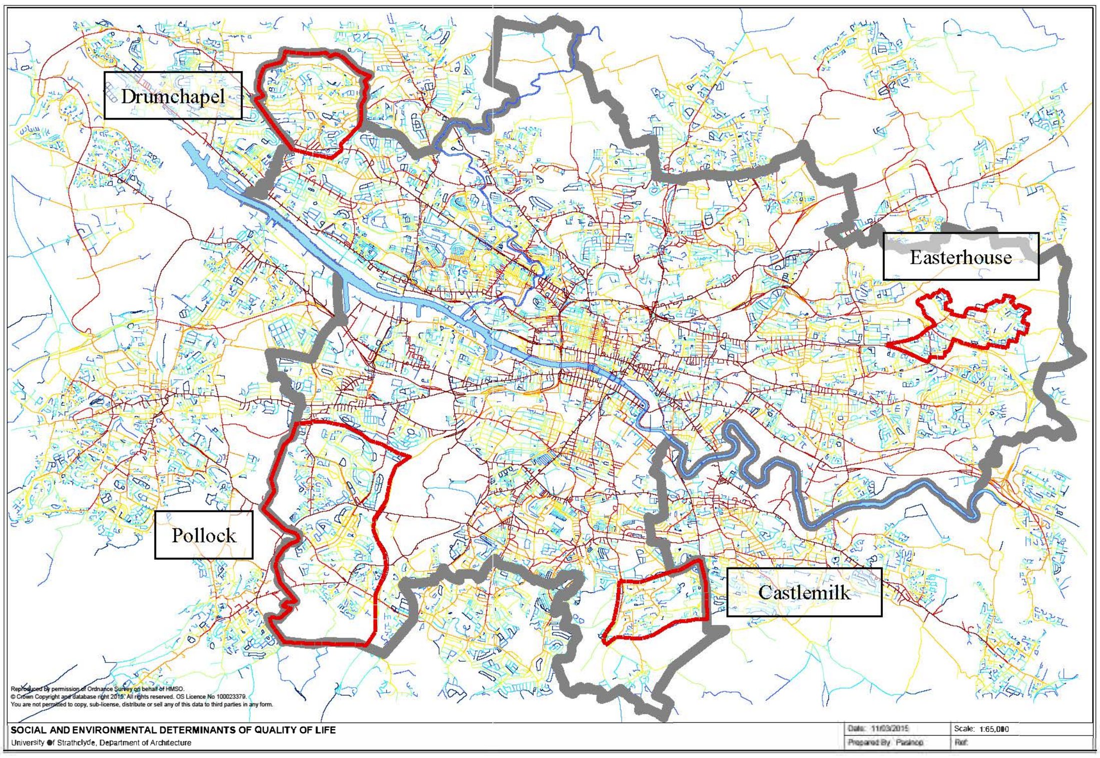


Figure 115. Thoroughfares with high levels of Betweenness index surround the Post war developments in Glasgow, which in the map above are enclosed in a red boundary. The peripheral estates are distributed at the 4 corners of the boundary: Drumchapel at the North West, Pollok at the South West, Castlemilk at the South East and Easterhouse at the North East.

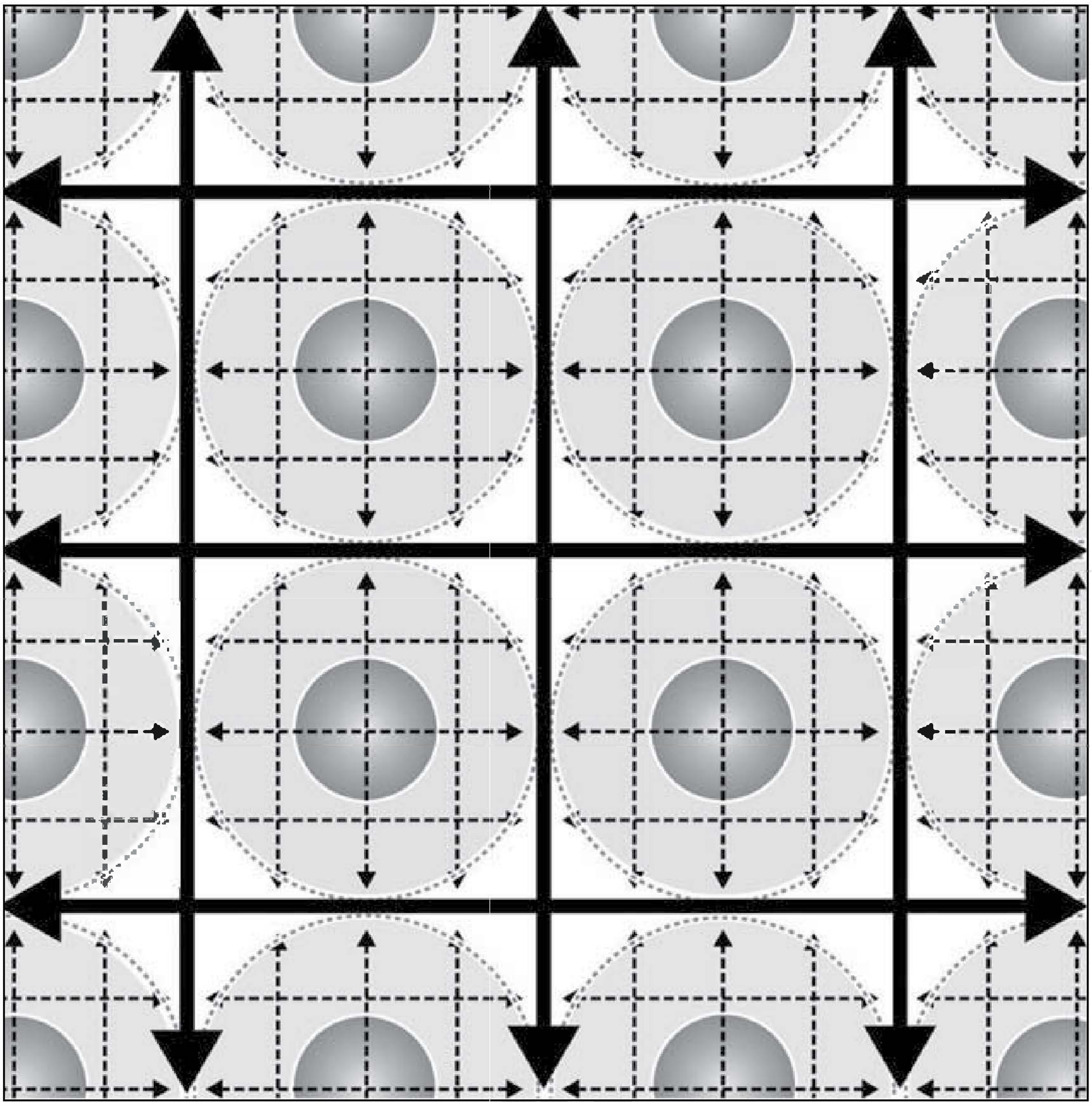


Figure 116. Centred/Shielded Nucleus: major thoroughfares surround the nucleus but are detached from it (Mehaffy et al., 2010).

communities. Also this approach creates neighbourhood that are entrapped between major thoroughfares and are not able to expand, evolve as socio cultural formations rather than geographical entities ((Mehaffy et al., 2010) (A., 1992).

Often this approach results in high-density mono functional clusters, built at the edge of cities, and ill connected to any urban nucleus. Normal urban life does not develop in such localities because of the lack of urban variety and connectivity with the surrounding areas.

This model is fully represented by Glasgow's peripheral post war housing estates; the estates are surrounded by thoroughfares with high levels of Betweenness index but internally layouts are poorly connected and do not encourage movement on foot. Often public spaces do not offer and environment conducive to co presence in space and public life.

Maps in Figure 117, Figure 116, Figure 117 and Figure 118 illustrate the typology of the shielded nucleus as described above.

The high level of Betweenness index in the thoroughfares surrounding the estates confirms that the shielded nuclei model has been applied to the design of the four

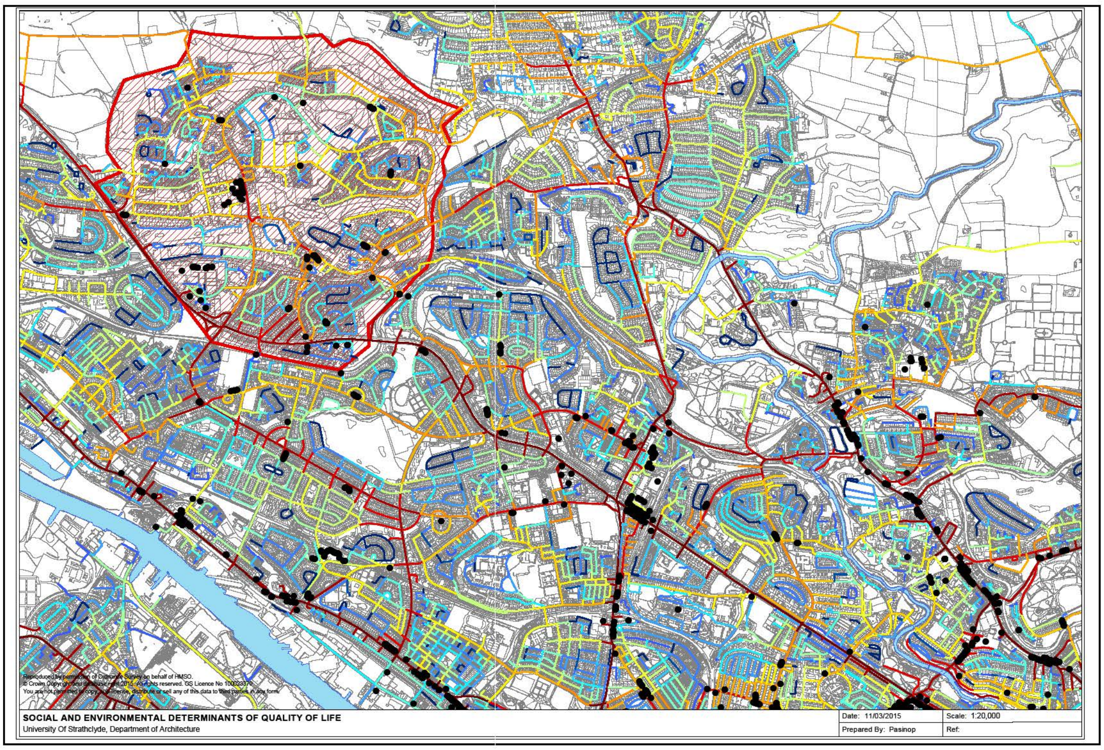


Figure 117. Thoroughfares with high levels of Betweenness surround Drumchapel. Betweenness levels decrease dramatically inside the development. Scale 1:20000 @A3

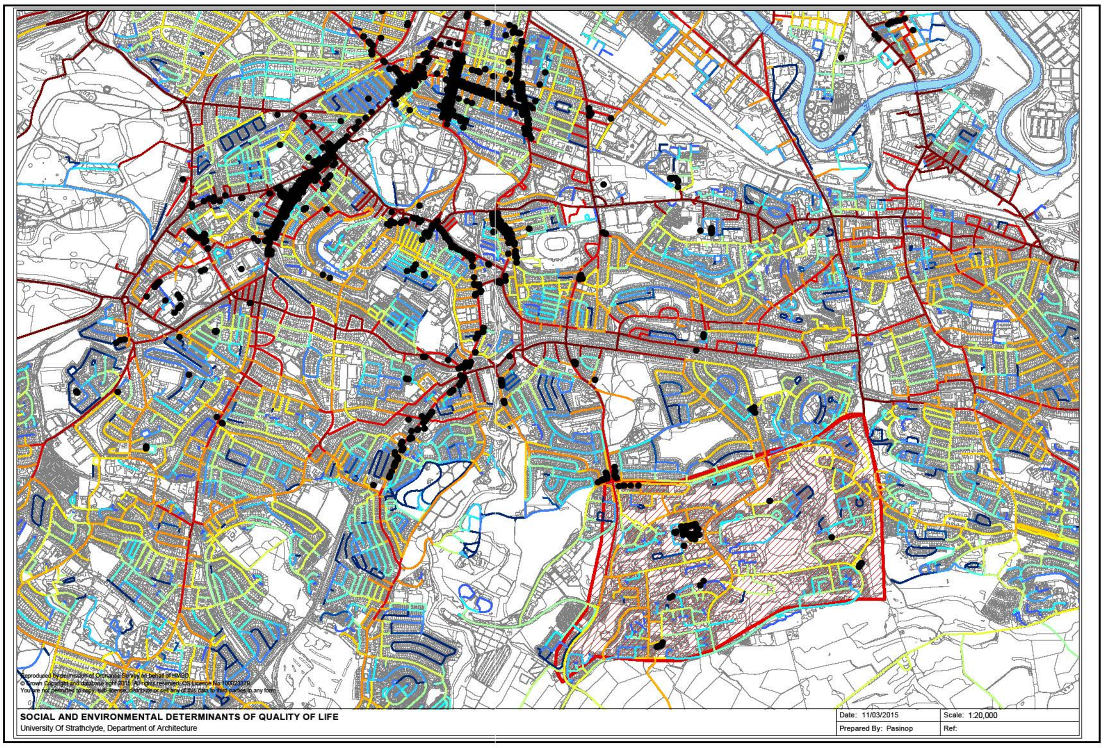


Figure 118. : Thoroughfares with high levels of Betweenness surround Castlemilk. Betweenness levels decrease dramatically inside the development. Scale 1:20000 @A3

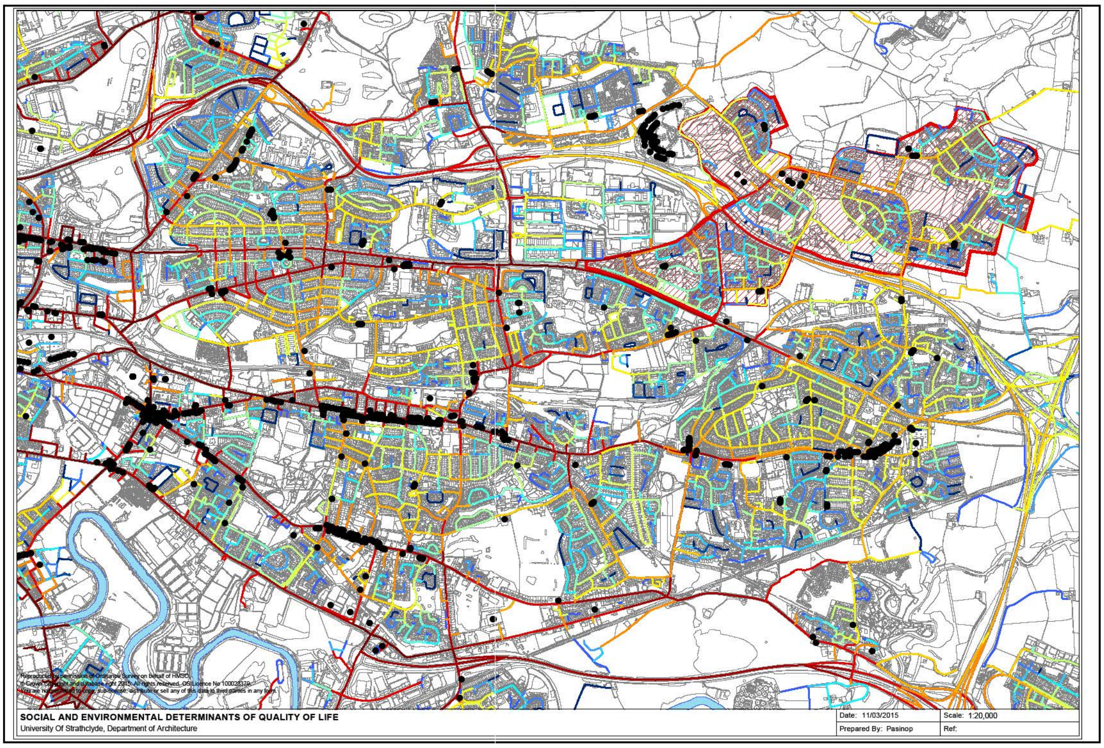


Figure 119. Thoroughfares with high levels of Betweenness surround Easterhouse. Betweenness levels decrease dramatically inside the development. Scale 1:20000 @A3

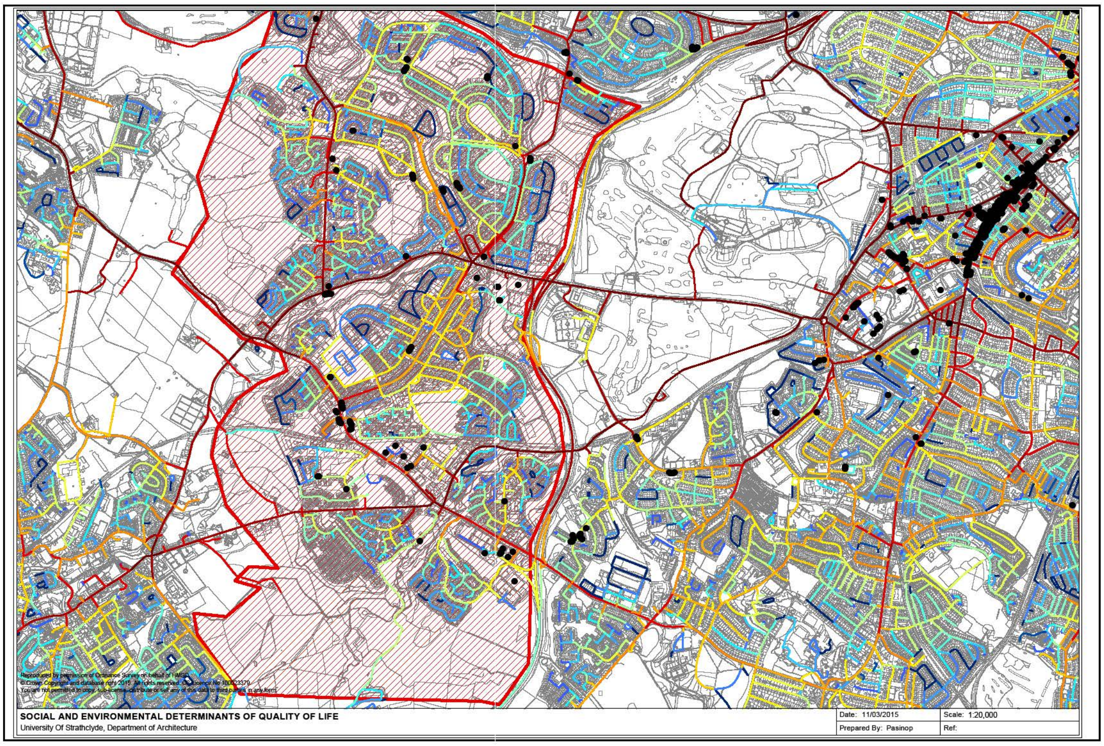


Figure 120. Thoroughfares with high levels of Betweenness surround the different phases of development in Pollok. Betweenness levels decrease dramatically inside the developments. Scale 1:20000 @A3

estates.

Examining the closeness index offers the opportunity of understanding how movement works inside the estates.

A harsh built environment designed for car movement rather than for people aggravates the structural low of accessibility of the built environment in Drumchapel, as demonstrated in Figure 125, Figure 126, Figure 127 and Figure 128.

The same scenario presents itself in the remaining three housing estates.

Figure 121. : Drumchapel Betweenness Index and Commercial activities; Services are located along an axis with moderately high levels of Betweenness; the area surrounding the shopping centre is inhospitable with an industrial area, large patches of unused grass, roads designed for car traffic and not pedestrian movement.

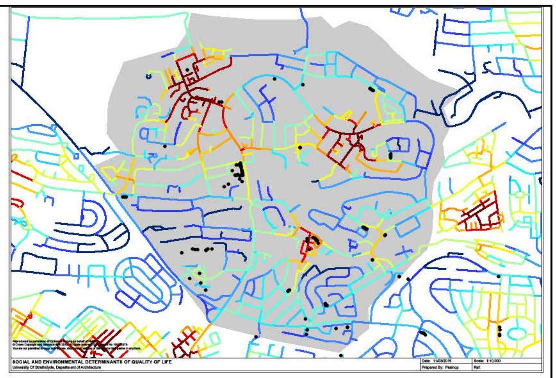


Figure 122. services are located in areas which are not easily reachable on foot, due to the existing built environment in the area and also as demonstrated by the closeness @400m index. Areas that present high levels of closeness at 400 are concentrated around the residential developments, which in turn are isolated from services and commerce.

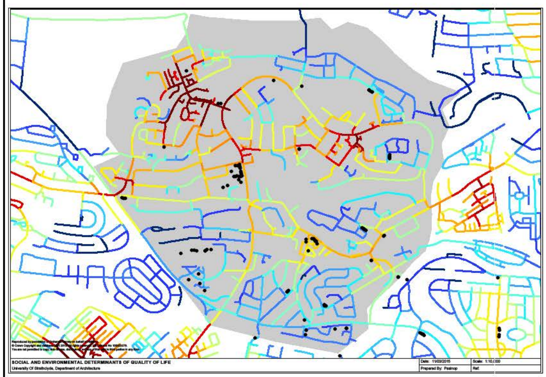


Figure 123. Closeness @800; values improve in the northern part of the estate, but peripheral areas are still inaccessible.

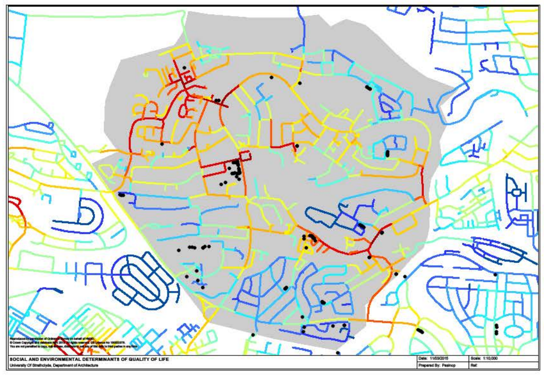


Figure 124. Closeness @1600; values improve in the northern part of the estate, but peripheral areas are still inaccessible.

Figure 125. Access to the estate of Drumchapel is not pedestrian friendly (Google Earth) and presents low levels of centrality indexes, Betweenness, Closeness at 400, 800 and 1600 m. (Image ©2015 Google)

Figure 126. Commercial units in Drumchapel; the units appear run down, vacant and do not offer a quality public space able to foster co presence in space (Google Earth). This strip of commercial units is located in a hub which presents good levels of centrality indexes, but is disconnected from the residential areas around it. (Image ©2015 Google)

Figure 127. The remaining tower blocks in Drumchapel. The rationalist approach to this portion of the estate does not offer a pedestrian friendly environment; green areas are not active and pavements run along fences. The absence of eyes on the road does not assist with a sense of security and pedestrian movement is not encouraged by the built environment; levels of Closeness at 400, 800 or 1600 are extremely low on the paths that lead to the towers (Image ©2015 Google)

Figure 128. Drumchapel Shopping Centre presents empty units, low quality shopping offer, poor pedestrian environment (Google Earth). This shopping area is well positioned at the centre of the Estate, but the surrounding residential hubs around it present such low levels of centrality indexes, offer such low accessibility, that are in fact segregated from the services at the centre of the community. (Image ©2015 Google)

Figure 133. *Shopping area in Pollok. The environment is car dominated and not suitable for pedestrian movement. (Image ©2015 Google)*

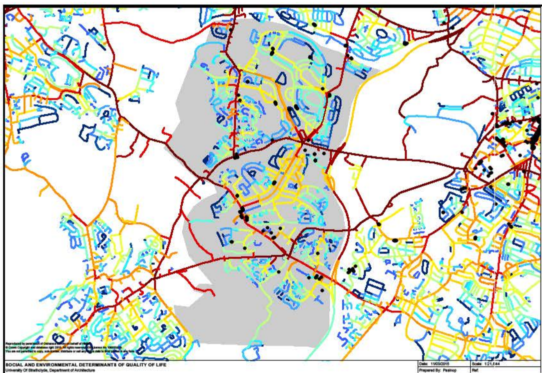


Figure 129. *Betweenness index and commercial units in Pollok. Axes with high levels of Betweenness enclose the residential areas with low levels of Betweenness*

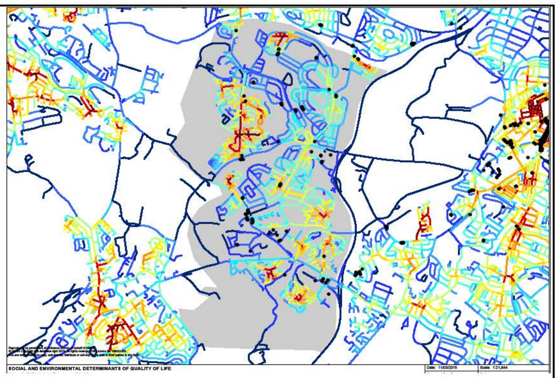


Figure 130. *Closeness @400m. The whole estate performs poorly with the closeness index. The layout is generally disconnected and not easy to navigate on foot. Commercial activities are located in areas that do not offer high levels of closeness and re therefore not likely to be reached on foot easily.*

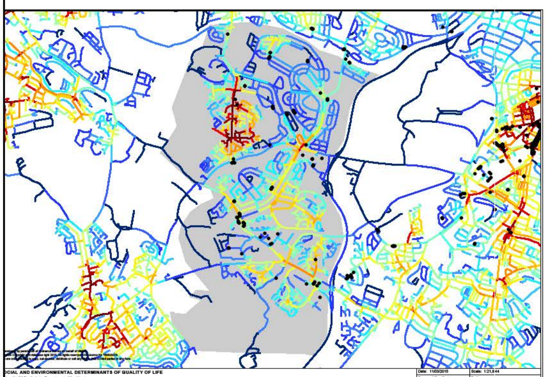


Figure 131. *Closeness @800m.*

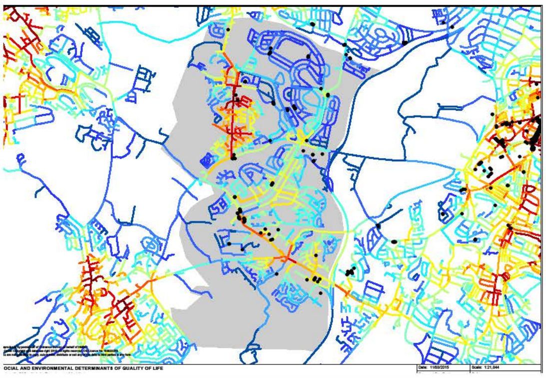


Figure 132. *Closeness @1600.*

Figure 138. Castlemilk Health Centre on the left hand side and the landscape around it. The residential towers dominate the landscape in isolation. The environment is designed for car movement and not with people in mind. (Image ©2015 Google)

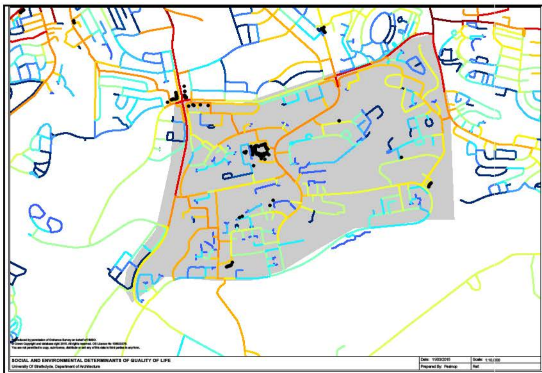


Figure 134. Betweenness index and commercial units in Castlemilk. The residential areas with low Betweenness index are surrounded by axis with high levels of Betweenness.

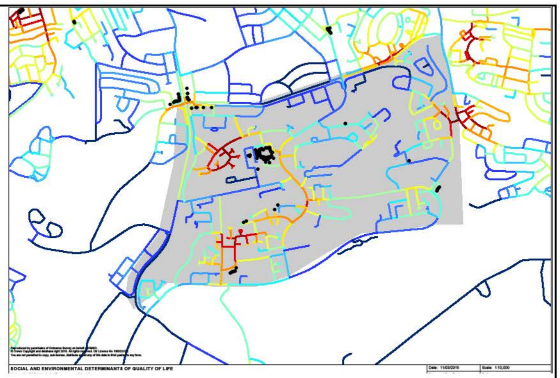


Figure 135. Closeness @400m in Castlemilk. Residential areas in Castlemilk do not perform well with the closeness centrality index. Services are located in a zone with low levels of closeness, indicating that they are not easily accessible from the residencies.

Figure 136. Closeness @800m.

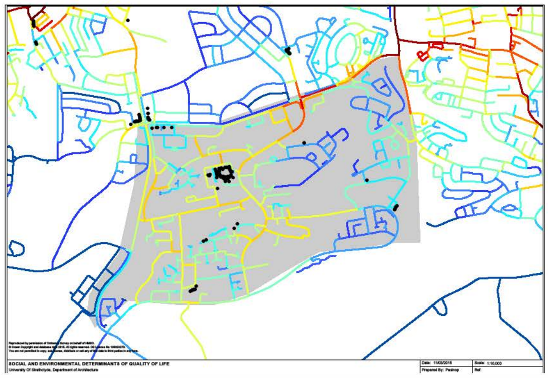


Figure 137. Closeness @1600.

Figure 139. : Easterhouse shopping centre is located in area with low closeness index values. At street level, the environment is not hospitable; pavements run along empty green spaces and the streets are car dominated. (Image ©2015 Google)

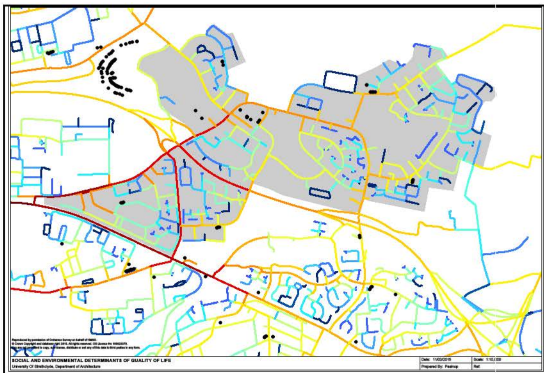


Figure 140. Betweenness index and commerce in Easterhouse. Axis with high levels of Betweenness surround the residential areas where Betweenness is low.

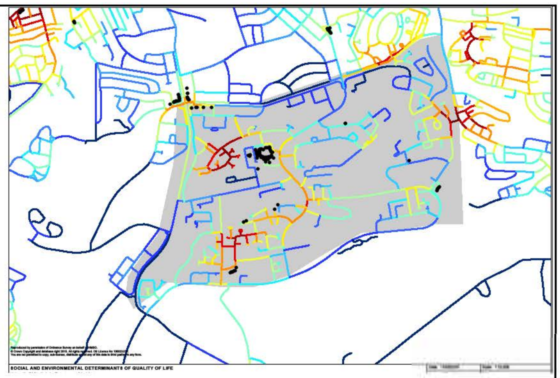


Figure 141. Closeness @400m in Easterhouse. Levels of closeness are generally low throughout the estate. Commerce is concentrated in an area with low levels of closeness.

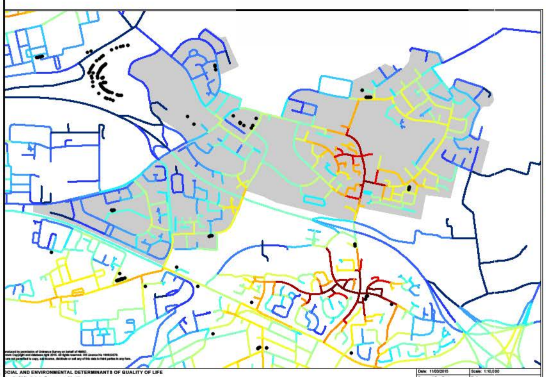


Figure 142. Closeness @800m.

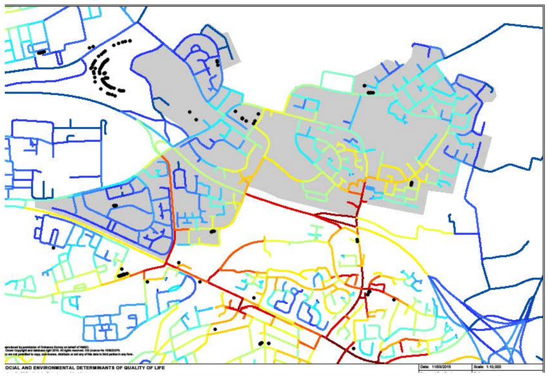


Figure 143. Closeness @1600.

7. Conclusions

7.1. Introduction

This chapter draws the conclusions from the analysis illustrated in Chapter “6. Case Studies and Findings” on page 205, and answers the research questions outlined in Chapter 1“Introduction” on page 15.

The key findings relative to the study of the correlation between the variation of centrality indexes and rateable values will discussed in section 7.5.

Anew approach to Quality of Life indicators will be outlined, as well as recommendations for further research.

7.2. Summary

As a result of the investigations contained in this research document, we would recommend that spatial configurational theories should be introduced as fundamental tools in the development of design recommendations for urban regeneration or new built proposals.

The process of opening access to data, and medical data in particular, should continue to improve in order to support future research on the relationship between health and space configuration.

7.3. Synthesis of the key findings

Quality of Life and Deprivation are a prioritised issue in Scotland and are the subject of comprehensive national and local initiatives.

Nevertheless, urban design has rarely been the focus of policies aimed at improving QoL or Deprivation; such issues have been largely addressed through social housing or community based initiatives.

This thesis argues that social housing and community initiatives are not the only tools that can be adopted to counteract issues of Deprivation or low Quality of Life and that the structure of the built environment has proven to correlate significantly with aspects of Quality of Life and urban policies.

The main focus of this thesis has been to explore aspects of Quality of Life and Deprivation in relation to urban form through a spatial configurational approach, which has required the introduction of a new set of theories, methodologies and tools, with a radical departure from the traditional approach to these issues.

The recommendations and results that follow from the approach proposed by this thesis are argued to have a greater degree of relevance for urban design implementations and for a deeper understanding of the role of space configuration in matters of social outcomes.

In the conclusions chapter “Conclusions” on page 298, the initial research questions will be readdressed through a summarization of the findings of the thesis.

The first and the second question investigated how space is described in the existing literature on Quality of Life and Deprivation and in existing governmental policies aimed at addressing social inequalities. The point of departure of these questions is the idea that the built environment has a great influence on people's behaviour and the importance of clarifying how the existing literature and policies had linked social outcomes to urban form.

The third question addresses the problem of redesigning concepts like QoL, Deprivation, Segregation, Social Inequalities to respond more directly to matters associated with urban design.

This has required a shift in the approach to those concepts, from an analysis of how socio economic indicators are distributed in space, to a theory that has the capability of capturing the characteristics of space itself (space distribution) that are conducive to the development of some aspects (positive or negative) contained within issues of QoL and Urban Policies.

The fourth and last question aimed to unveil how the introduction of configurational theories could deepen the understanding of the role of urban design in policies aimed at addressing low Quality of Life or Deprivation.

The case studies were carried out in Glasgow, Scotland, where the built environment has been investigated with a focus on the analysis of the properties of its urban form (space configuration) in relation to social consequences and outcomes.

A deeper understanding of the role of urban form in relation to social consequences and outcomes is suggested to lead to more effective urban design and planning solutions aimed at improving aspects of QoL.

The conclusions of this thesis will focus on the relationship between space and society with a particular interest on resiliency in urban design solutions, as Glasgow has just joined the 100 Resilient Cities Forum and has started its resilience challenge (,).

7.4. QoL and Urban Policies: what is the role of space configuration?

Quality of Life, Segregation, Deprivation, Well being, etc. issues range over many fields and often urban design and architecture are only addressed through policies focusing on housing.

However in thesis it has been argued that the composite indexes aimed at measuring levels of well-being are quite limited when it comes to issues related to urban design or more specifically, urban form.

Socio economic studies address how the different indicators for composite indexes of QoL or Deprivation are distributed in space, while urban design focuses on the influence of the built environment on people's behaviour.

Cities and neighbourhoods are classified according to their inhabitant's social profiles rather than according to their spatial properties; geographical units developed to implement such classifications are not often meaningful when considered at street level rather than on a map; architectural solutions focused solely on housing stocks neglect the possibility of enhancing co presence in public space, which is one of the aspects of Quality of Life that can be enhanced through urban design.

As a consequence, policies aimed at improving QoL in certain areas target the residents (social mix) or the housing stock (refurbishments) but do not address the role of public space in the equation.

This thesis argues that spatial structures change at a much slower rate than architecture or the socio economic composition of the inhabitants of a given area, and has a much greater impact on the social outcomes of a neighbourhood. As such it should enter the policy agenda as a support tool for designers and decision makers.

7.5. Urban design and Quality of Life

The third research questions focuses on how aspects of Quality of Life can be addressed through urban design.

The application of configurational theories requires a complete change of approach from a traditional socio-economic study; the focus of the analysis in fact shifts from positions in space to relations in space, from distribution in space to distribution of and through space.

The key question is no longer where the population classified through a certain indicator is located, but how urban form relates to people and to certain aspects (indicators) of Quality of Life, such as street vitality, co presence in space, accessibility of amenities through public space.

This thesis in particular addressed the analysis of the distribution of commercial activities and the variation of rateable values across the urban network of Glasgow in relation to centrality indexes across the same network.

While results of the analysis between presence of commerce and centrality indexes added to existing literature where similar studies had been conducted (Porta et al., 2007), etc, the analysis of centrality indexes and rateable values represents the element of novelty of this research.

Findings confirm the existence of a positive correlation between the two values (“Centrality Indexes and Rateable values” on page 256), adding another layer of evidence on the relationship between centrality indexes and the structural capability of a place to succeed.

This thesis argues that configurational theories and their tools (MCA) attempt to reflect the relationship between space distribution and people’s behaviour, allowing for a stronger focus on more human scale urban design solutions.

For example, in terms of housing policies, a configurational approach would not focus on dictating exactly what social mix should inhabit a certain area, but on creating the preconditions for co presence in space, which would foster meaningful social mixing.

7.6. A new approach to Quality of Life indicators

The last research question addresses the issue of how configurational approaches can deepen our understanding of the relationship between aspects of QoL and urban form. The analysis carried out on the urban network in Glasgow revealed that the overall structure of the city presents many discontinuities, in particular at local level, as highlighted by the Closeness Centrality index.

In fact Glasgow is an easily navigable city, with major thoroughfares that can easily move traffic (car or pedestrian) across its boundaries.

But the local level is not quite as efficient. With the exception of the City Centre, the West End and certain areas of the East End, local neighbourhoods in Glasgow are disconnected from the global level, not easy to navigate on foot and encourage a car dependent life style.

From the 1960s onwards clearance policies, the creation of peripheral estates and dislocation of services have effectively discouraged inner city living.

The drop in residential densities across the city's boundary is one of the major causes behind the decline of local Town Centres; the originally polycentric city has transformed in a car dependent monocentric city, which gravitates exclusively around the City Centre and some out of town shopping centres.

The configurational approach has been able to highlight the discontinuities in the urban form, which can be related to some aspects of Quality of Life such as:

1. Local neighbourhoods not easily navigable on foot:

   1.1. Car dependency, lack of active travelling opportunities, linked to poor health outcomes (Frank et al., 2006)

   1.2. Absence of co-presence in public space, linked to groups of QoL indicators like social capital and mind-set (Figure 6) .

   1.3. Spatial segregation, linked to absence of spontaneous social mix and amplification of neighbourhood effect (Atkinson et al., 2000), (Friedrichs et al., 2003)

   1.4. Scarce accessibility lo local and global amenities and services; accessibility is employed as indicator of QoL in most indexes review in the literature review of this thesis

When comparing different neighbourhoods, with different social mixes and different social outcomes, the consequences of a built environment, which is not easily navigable on foot, are different, but never negligible. Lack of active travel and a sense of isolation due to lack of suitable public spaces where to interact and socialize, can affect anybody independently from the socio economic background, and in particular children or the elderly population.

Configurational theories are therefore able to inform which change sin the structure of the built environment would be beneficial towards higher levels of QoL.

In Glasgow, the recently published City Centre Strategy (Glasgow Young Scot, 2015), recognizes the importance of encouraging higher densities of residential activities in the City Centre, and a configurational approach could ensure the delivery of new sustainable neighbourhoods able to re address the balance between functions that is currently missing.

7.7. Final discussion

The urban system of Glasgow is characterized by issues of segregation due to the ruptured interface between the structure of its global and the local level, as highlighted by the configurational approach adopted in this thesis.

It has been found that the urban form in most residential neighbourhoods in Glasgow is not able to foster positive social use and is not conducive to the development of a thriving civic life.

The history of development of Glasgow demonstrates how preconditions for co-presence in space facilitated by the built environment have decreased from the 1960s forward with the spread of the modernist movement in planning and architecture.

A built environment able to facilitate co-presence in space is by no means the only precondition to improved levels of Quality of Life, but nevertheless a necessary one, as demonstrated by a long history of failing urban policies.

Configurational theories are able to capture a more nuanced knowledge of the relationship between urban form and social outcomes and it is argued that his enhances the discussion about space and society as well as social sustainability and resiliency in urban design.

Concluding, this thesis argues that urban form plays an important role in spatial advantage and disadvantage and that urban design as a discipline can address some aspects relative to the improvement Quality of Life through improved public policies implemented thanks to the employment of configurational theories.

7.8. Recommendations for future research

The approach to data sharing has changed considerably since the beginning of this research.

In April 2014 Scottish Government created a Data management Board which developed a Data Vision for Scotland, to support trustworthy use of data for public benefit, research, and promote safe, secure and transparent use of data.

As a result of this change in attitude, much more datasets have been made available to researchers, and procedures have been put in place for accessing data while preserving the populations' right to privacy.

In particular, the possibility of accessing health data at a finer grain, would now enable the development of research on the relationship between the occurrence of methadone prescriptions, hospitalizations due to alcohol abuse, cardiac complications, etc and urban form, to provide further supporting evidence to the role of space configuration in the creation of thriving and healthy places.

8. Appendix

8.1. Appendix 1: Town Centres and Betweenness index

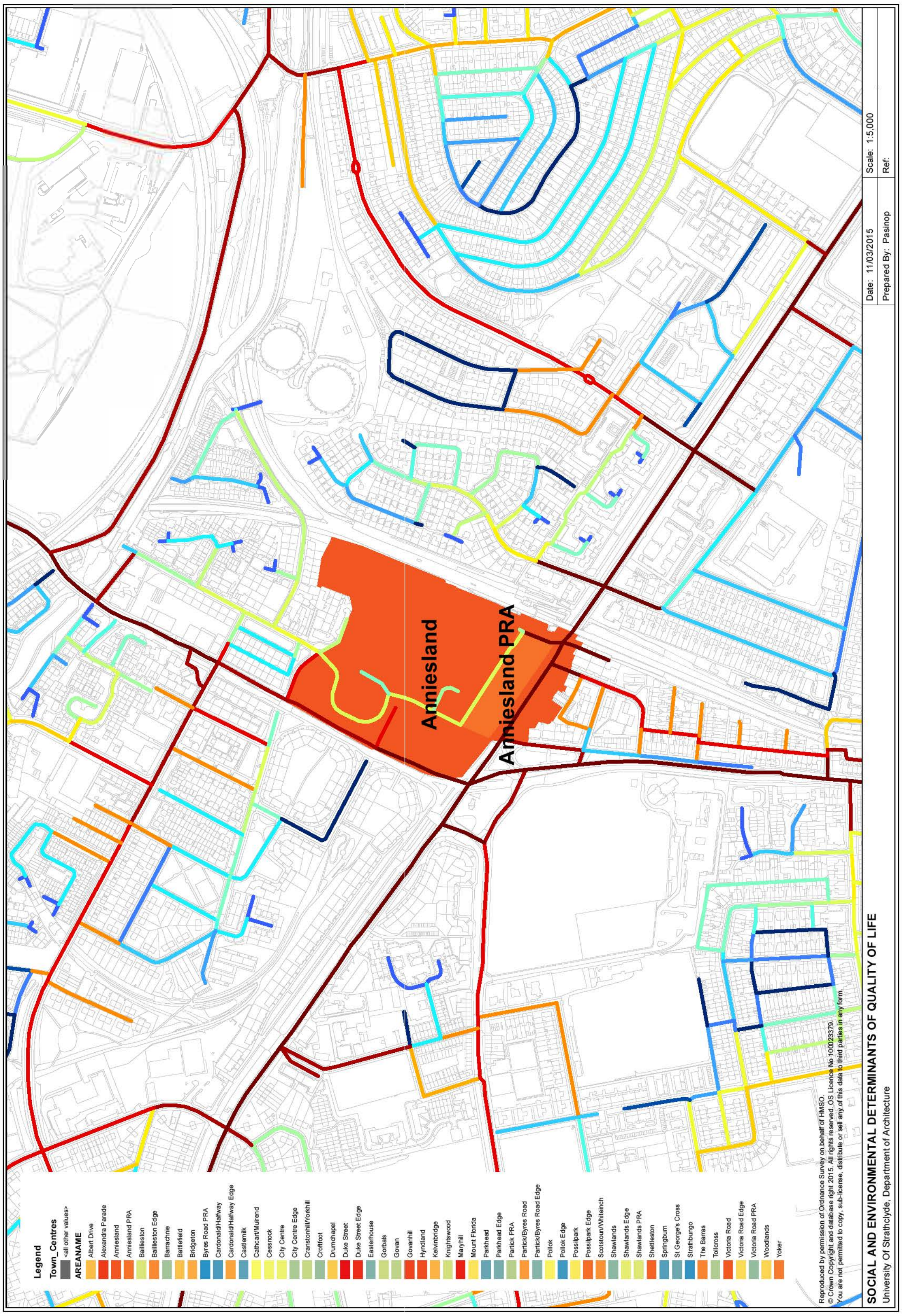


Figure 144. Betweenness Centrality Index. Town Centre: Anniesland.pdf

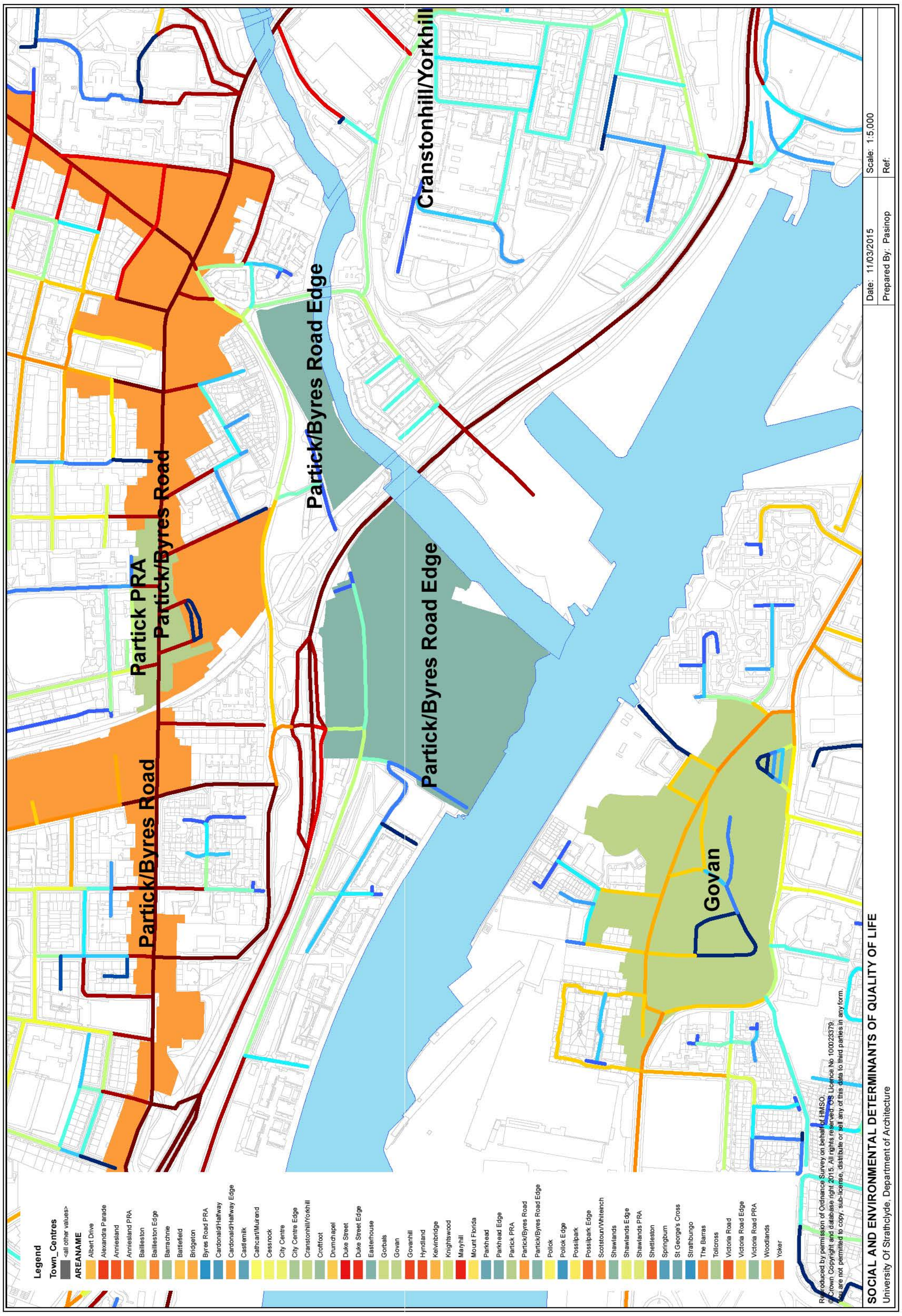


Figure 145. Betweenness Centrality Index. Town Centre: Partick_Byres Road Edge.pdf

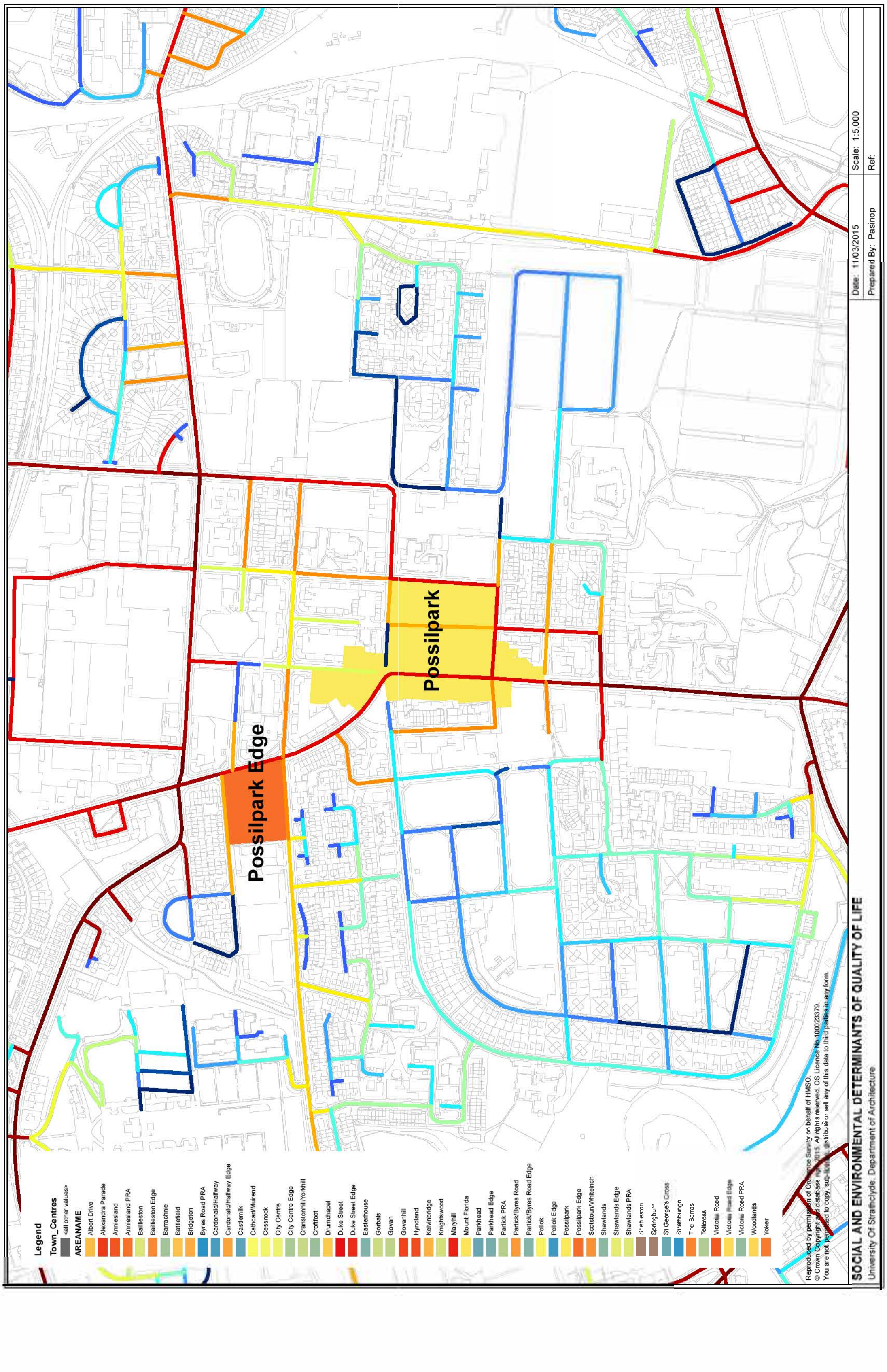


Figure 146. *Betweenness Centrality Index. Town Centre: Possilpark.pdf*

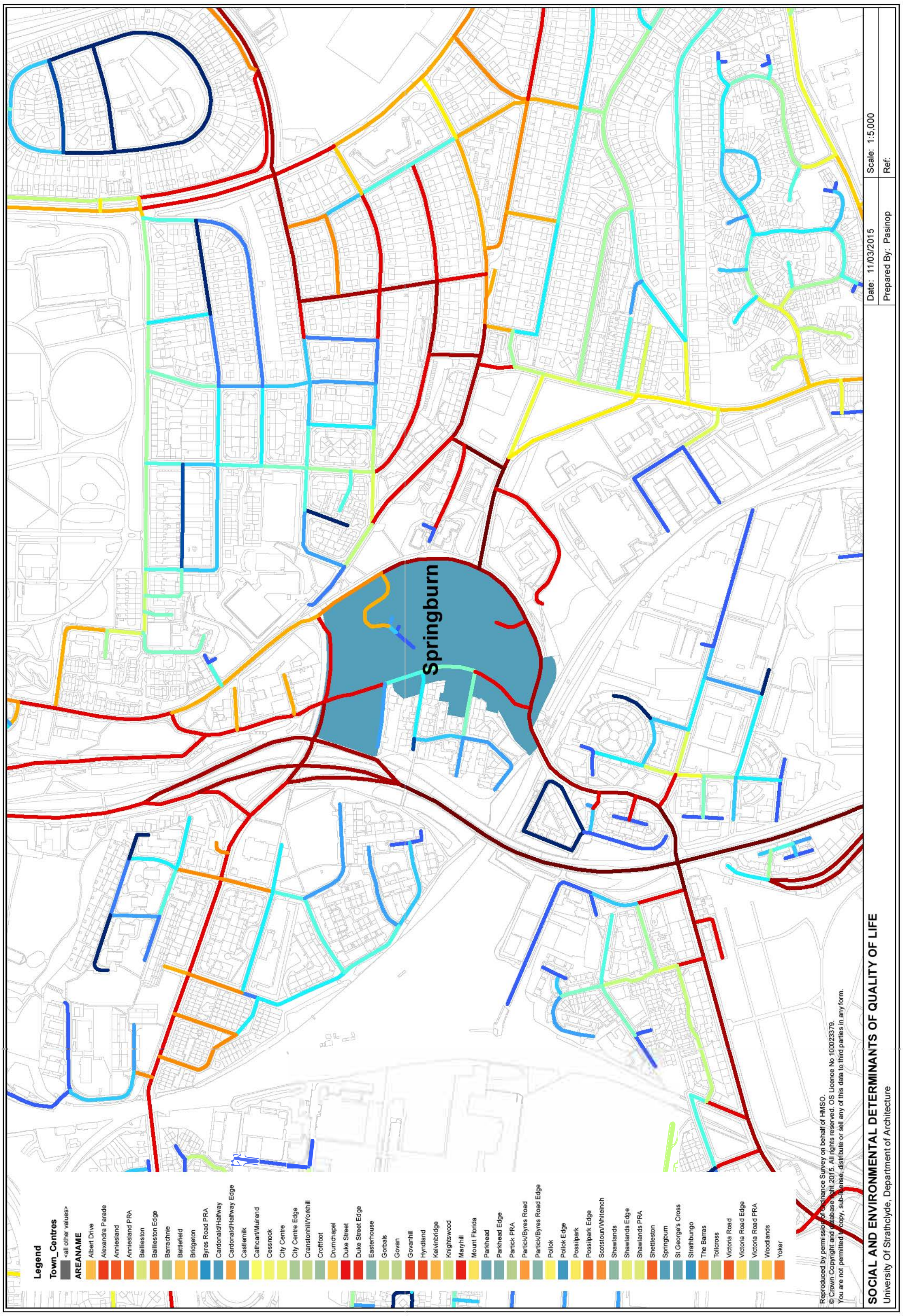


Figure 147. Betweenness Centrality Index. Town Centre: Springburn.pdf

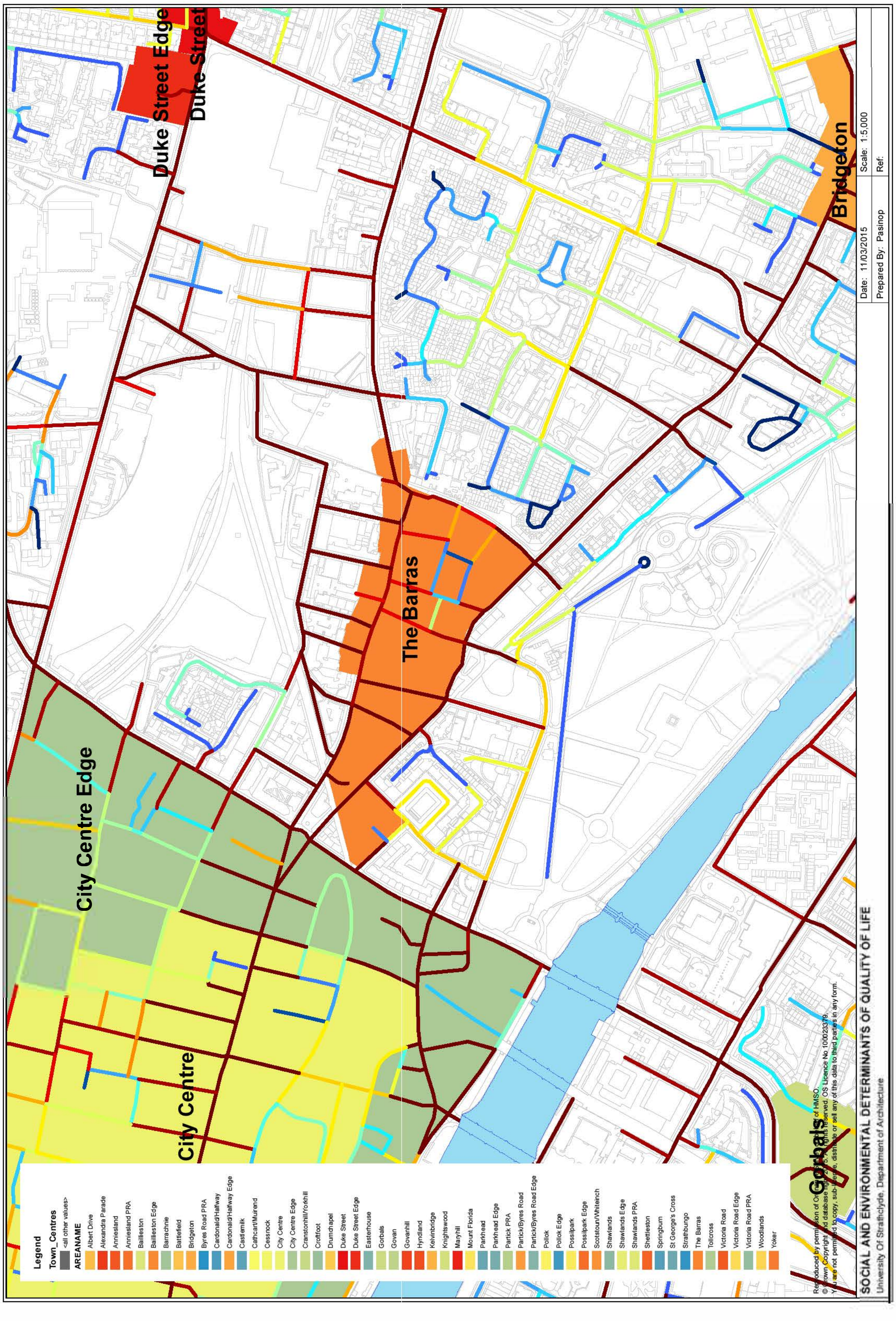


Figure 148. Betweenness Centrality Index. Town Centre: The Barras.pdf

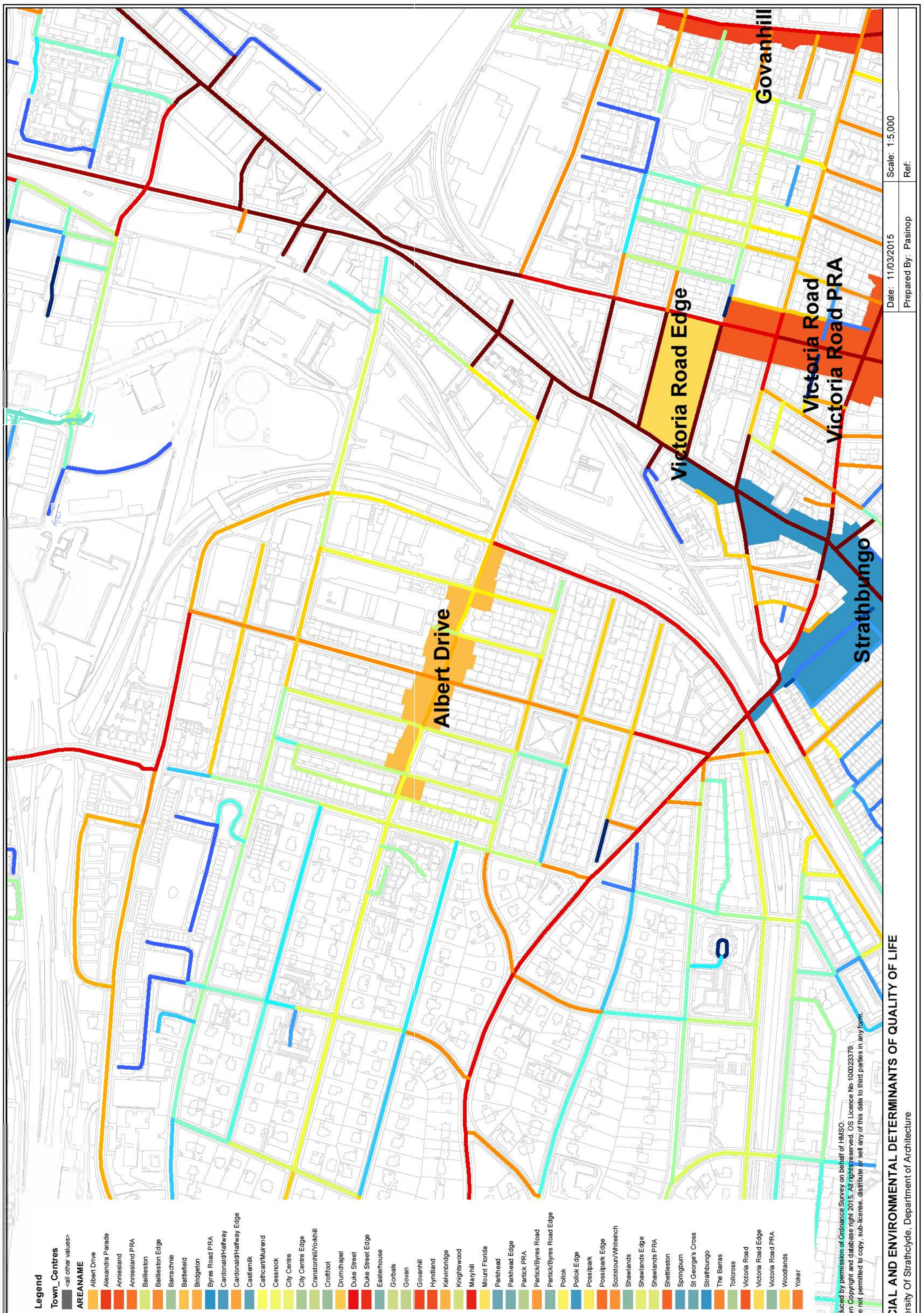


Figure 149. Betweenness Centrality Index. Town Centre: Albert Drive.pdf

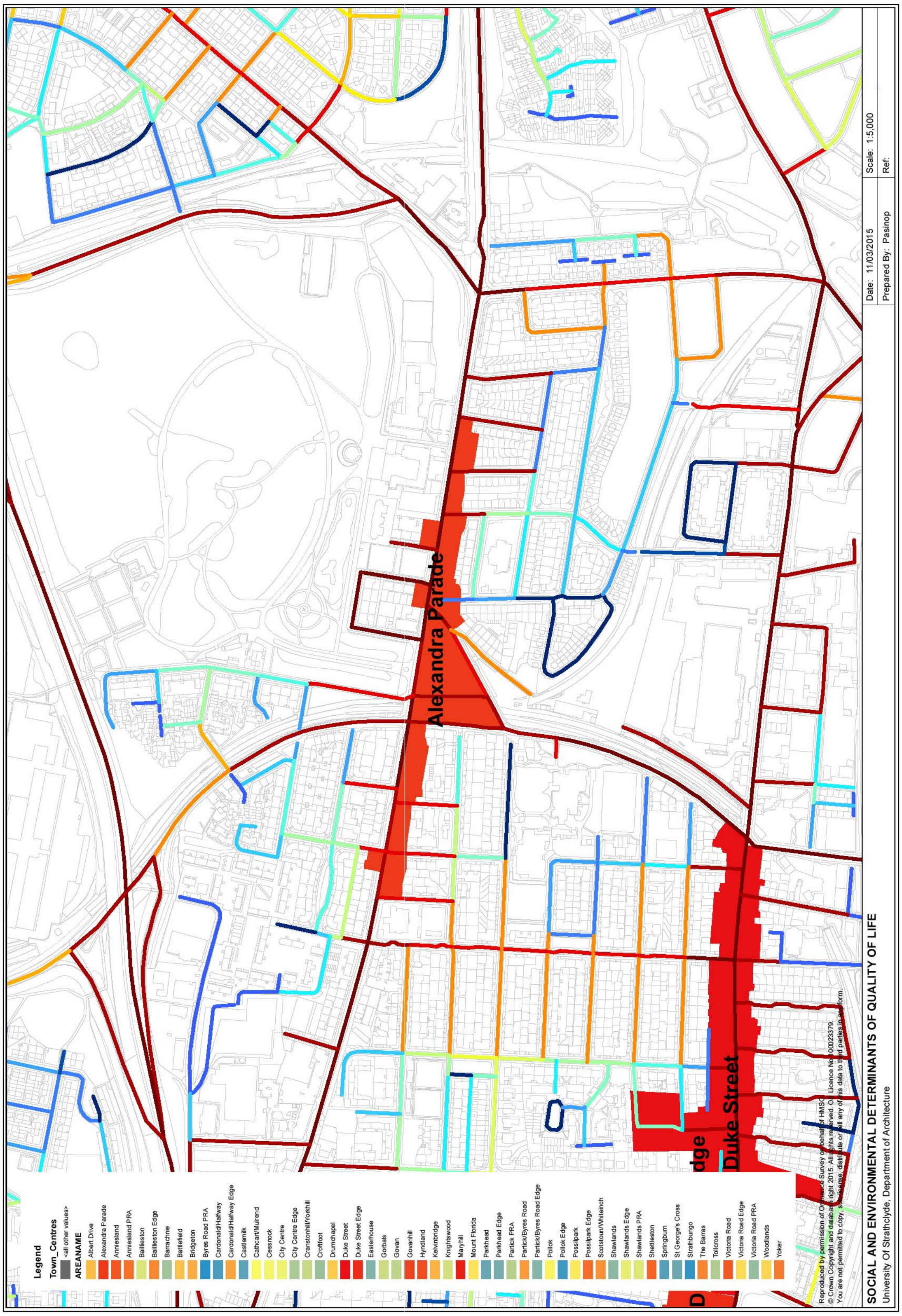


Figure 150. Betweenness Centrality Index. Town Centre: Alexandra Parade.pdf

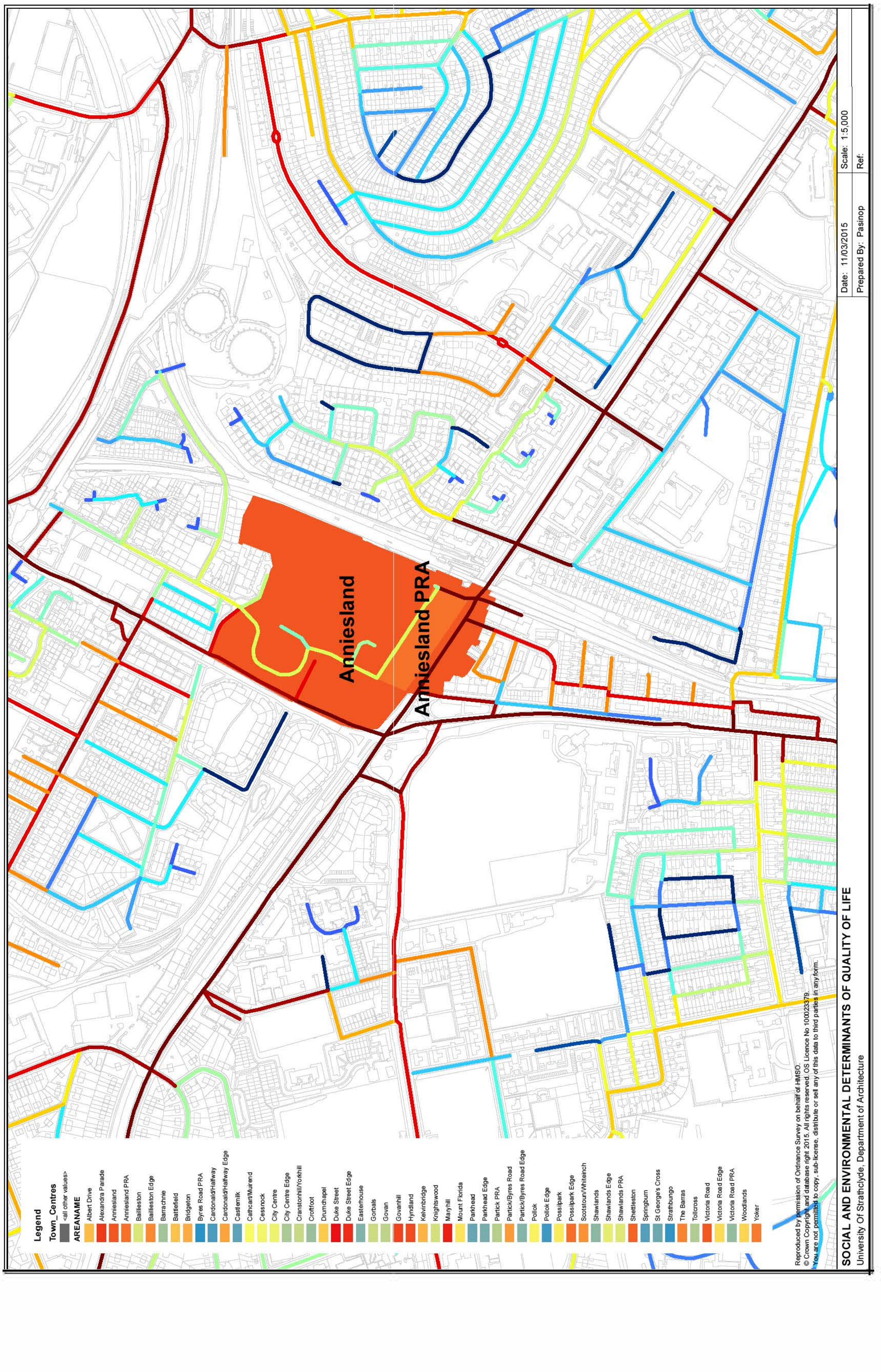


Figure 151. Betweenness Centrality Index. Town Centre: Anniesland PRA.pdf

Figure 152. Betweenness Centrality Index. Town Centre: Baillieston Edge.pdf

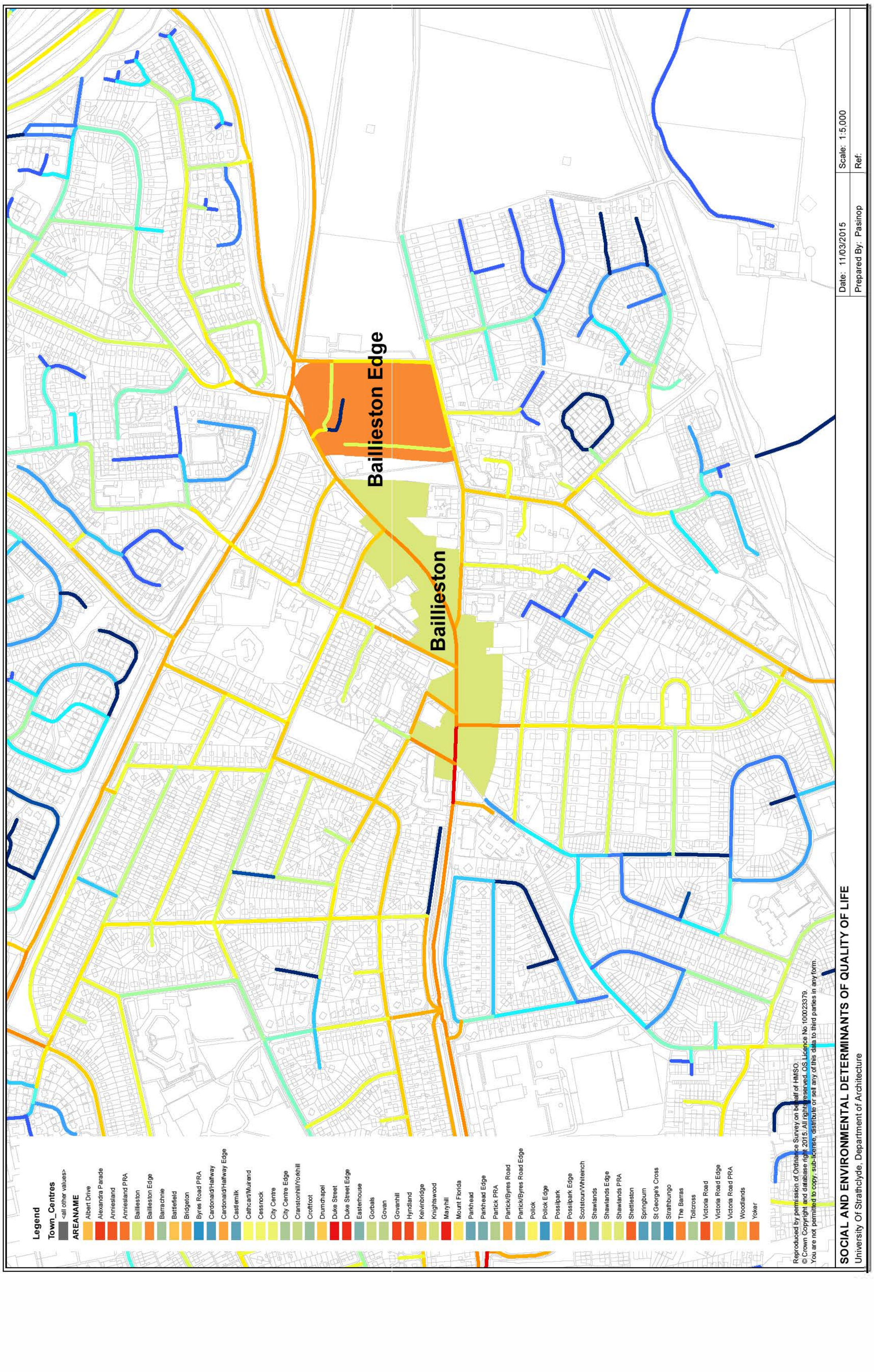


Figure 153. Betweenness Centrality Index. Town Centre: Baillieston.pdf

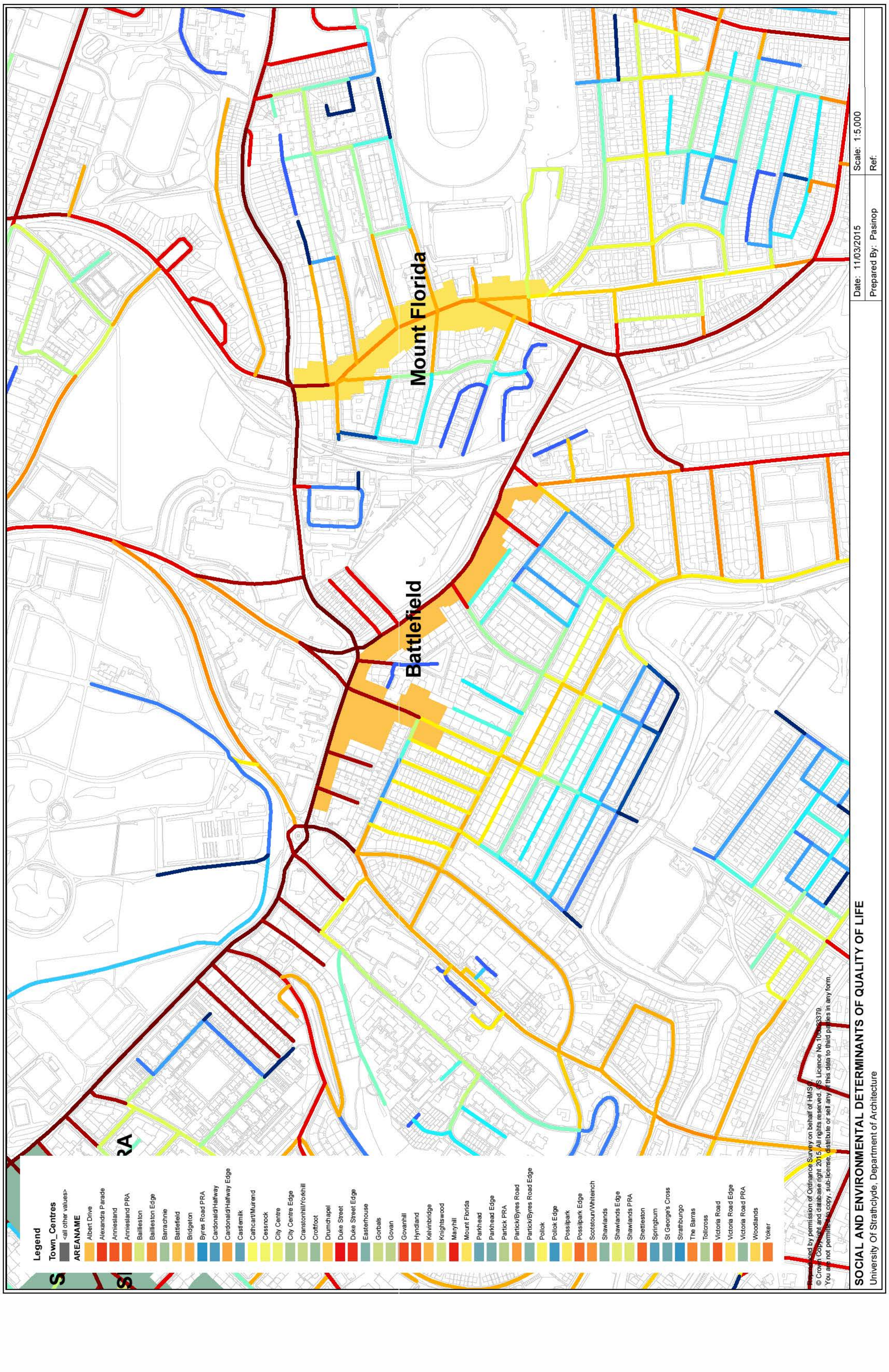


Figure 154. Betweenness Centrality Index. Town Centre: Battlefield.pdf

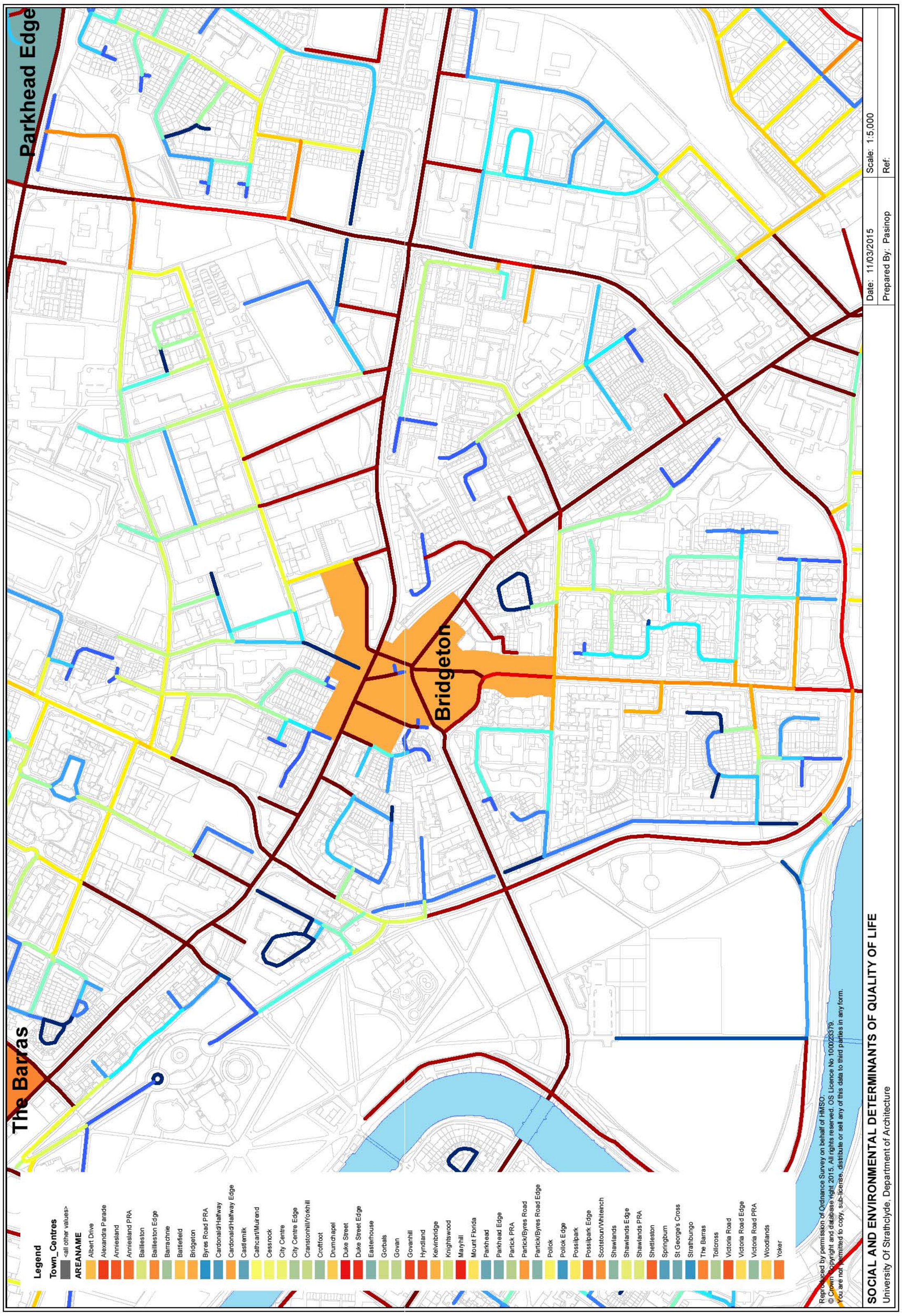


Figure 155. Betweenness Centrality Index. Town Centre: Bridgeton.pdf

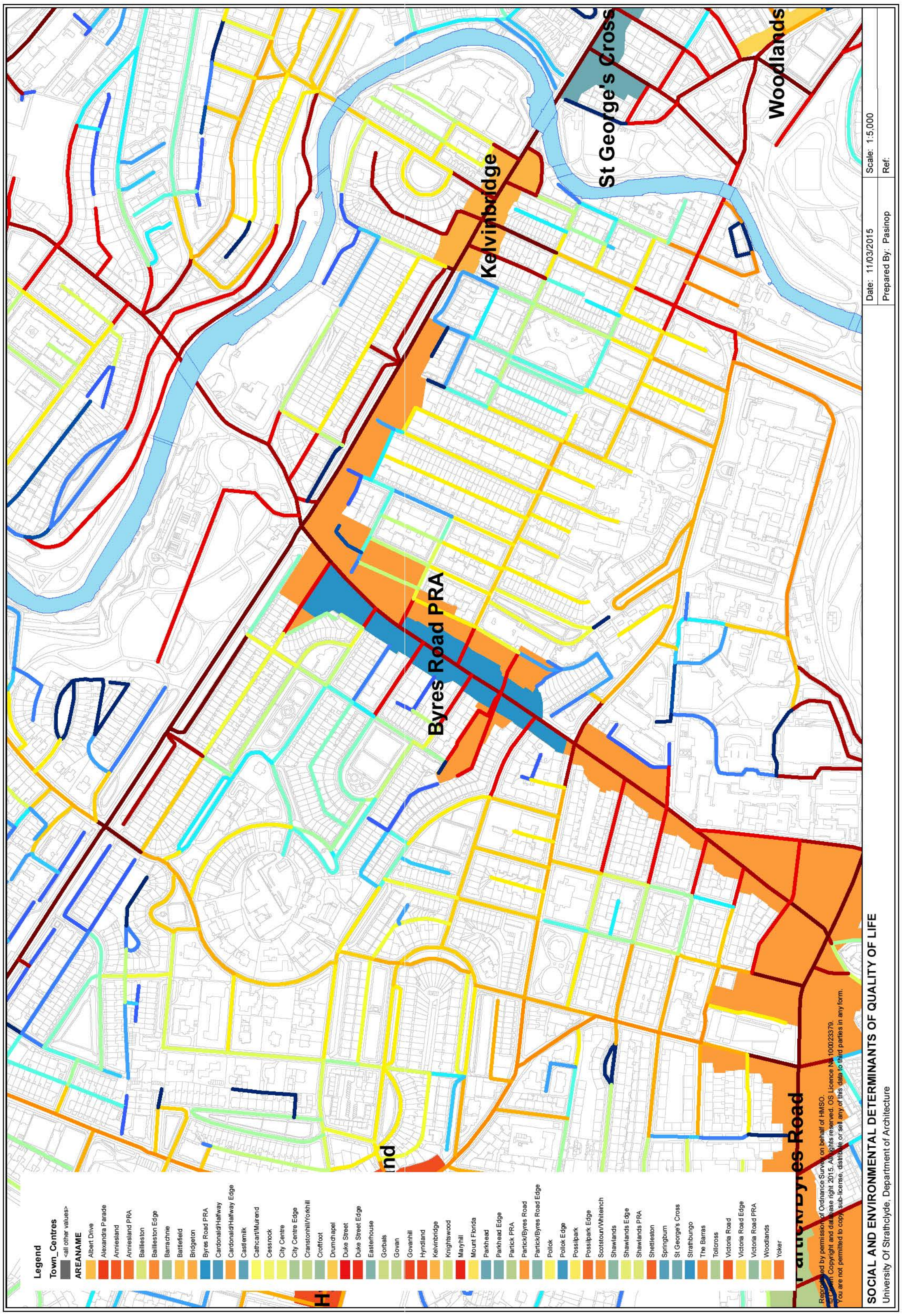


Figure 156. Betweenness Centrality Index. Town Centre: Byres Road PRA.pdf

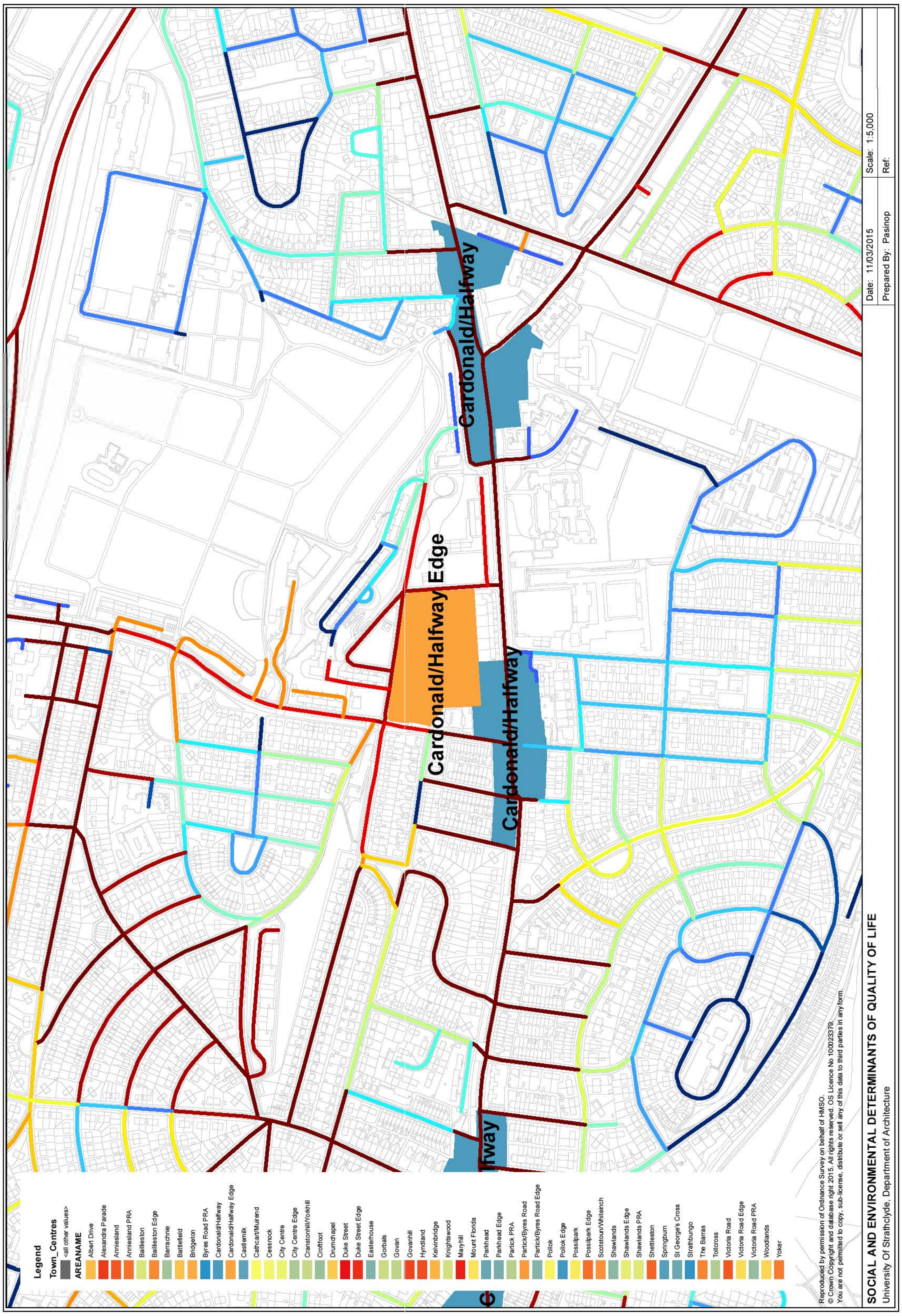


Figure 157. Betweenness Centrality Index. Town Centre: Cardonald_Halfway Edge.pdf

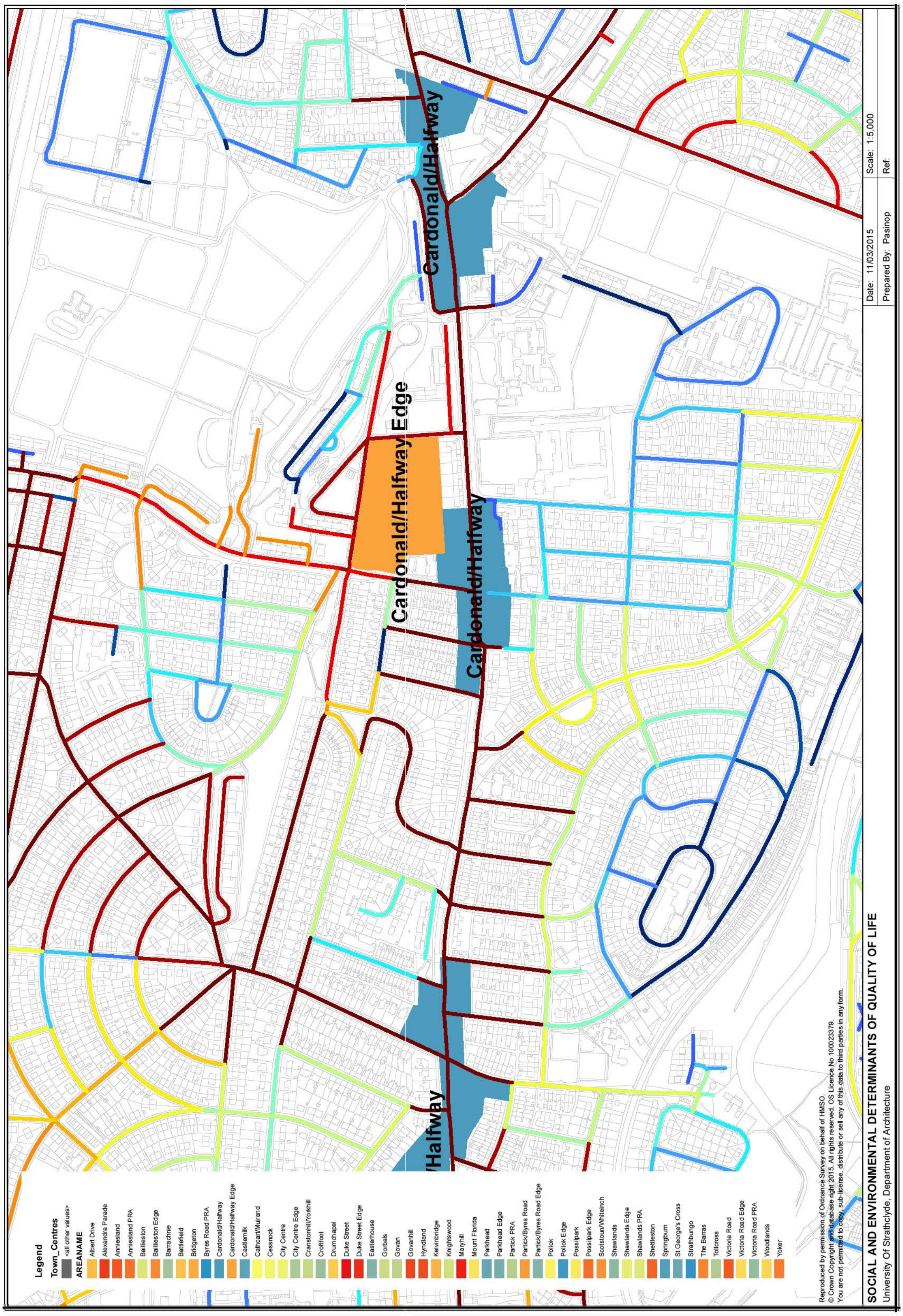


Figure 158. *Betweenness Centrality Index. Town Centre: Cardonald_Halfway.pdf*

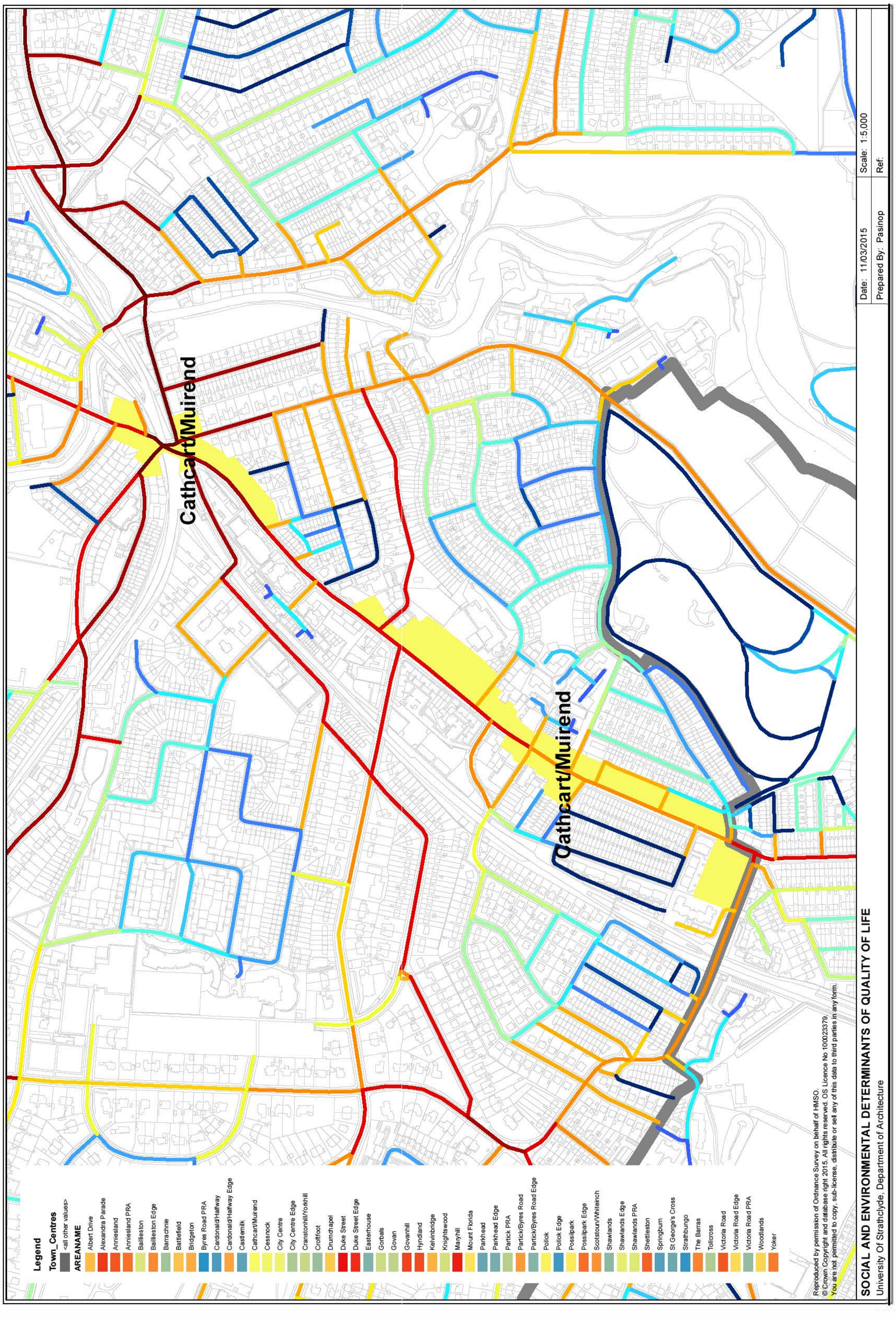


Figure 159. Betweenness Centrality Index. Town Centre: Cathcart_Muirend.pdf

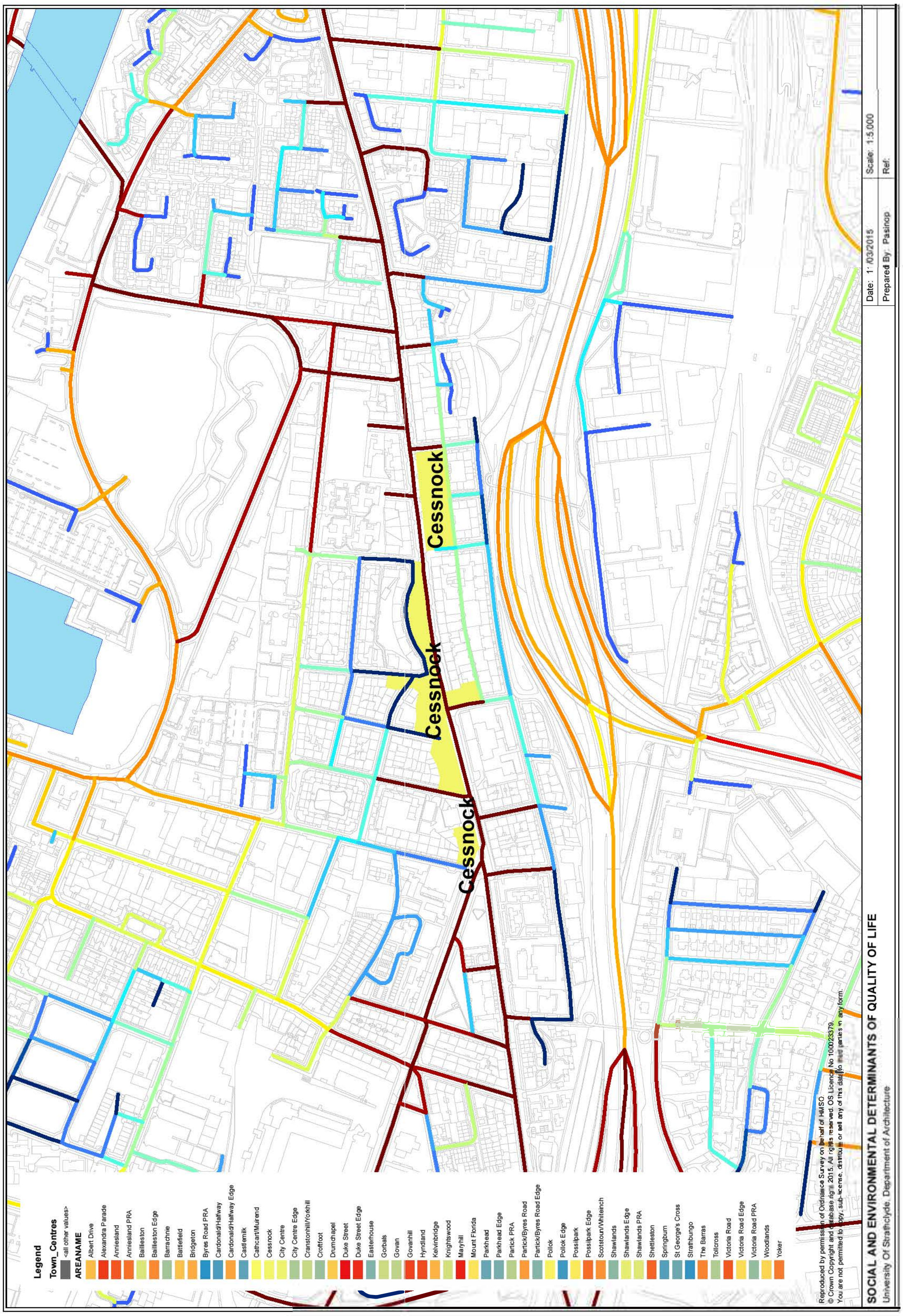


Figure 160. Betweenness Centrality Index. Town Centre: Cessnock.pdf

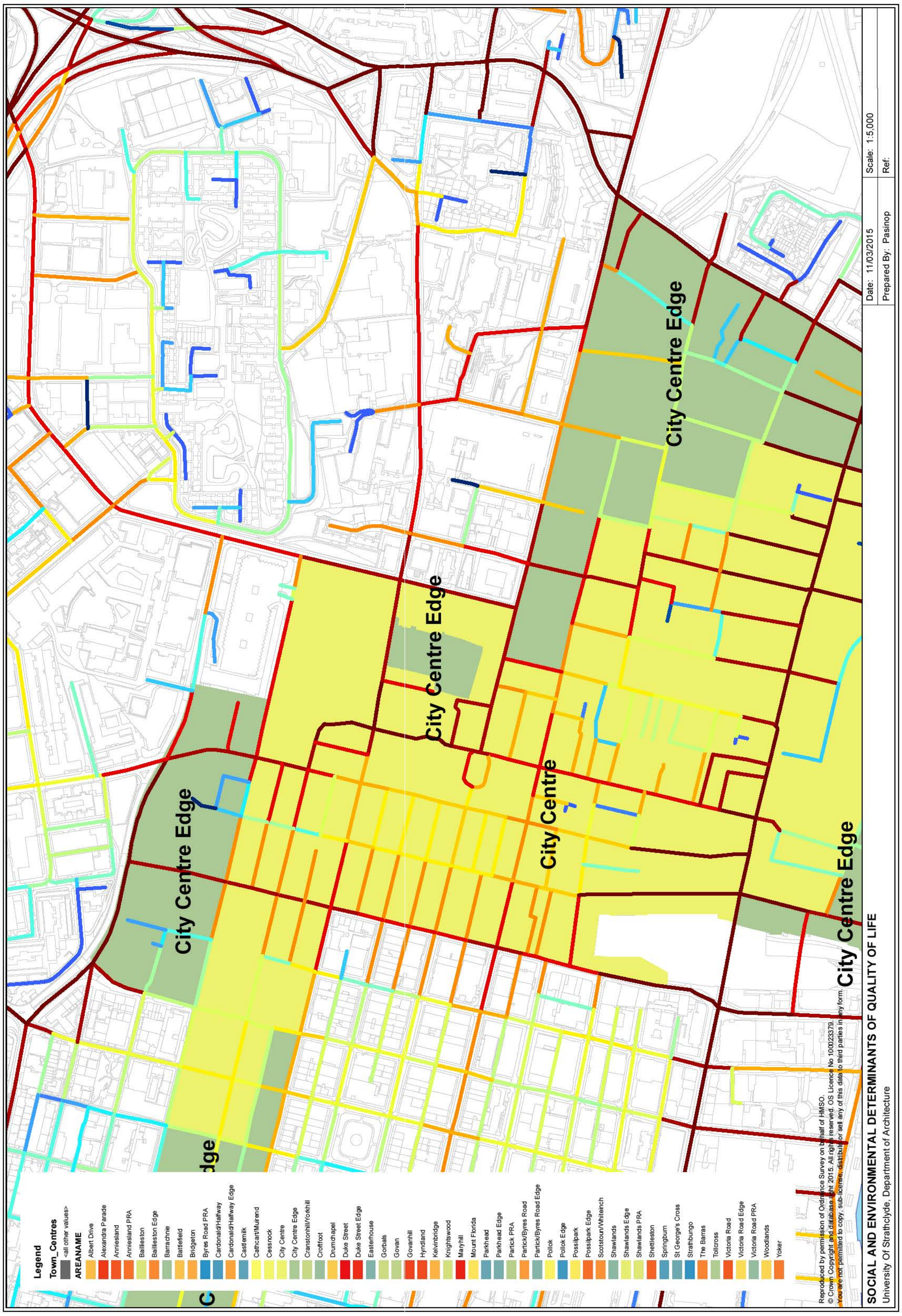


Figure 161. *Betweenness Centrality Index. Town Centre: City Centre Edge.pdf*

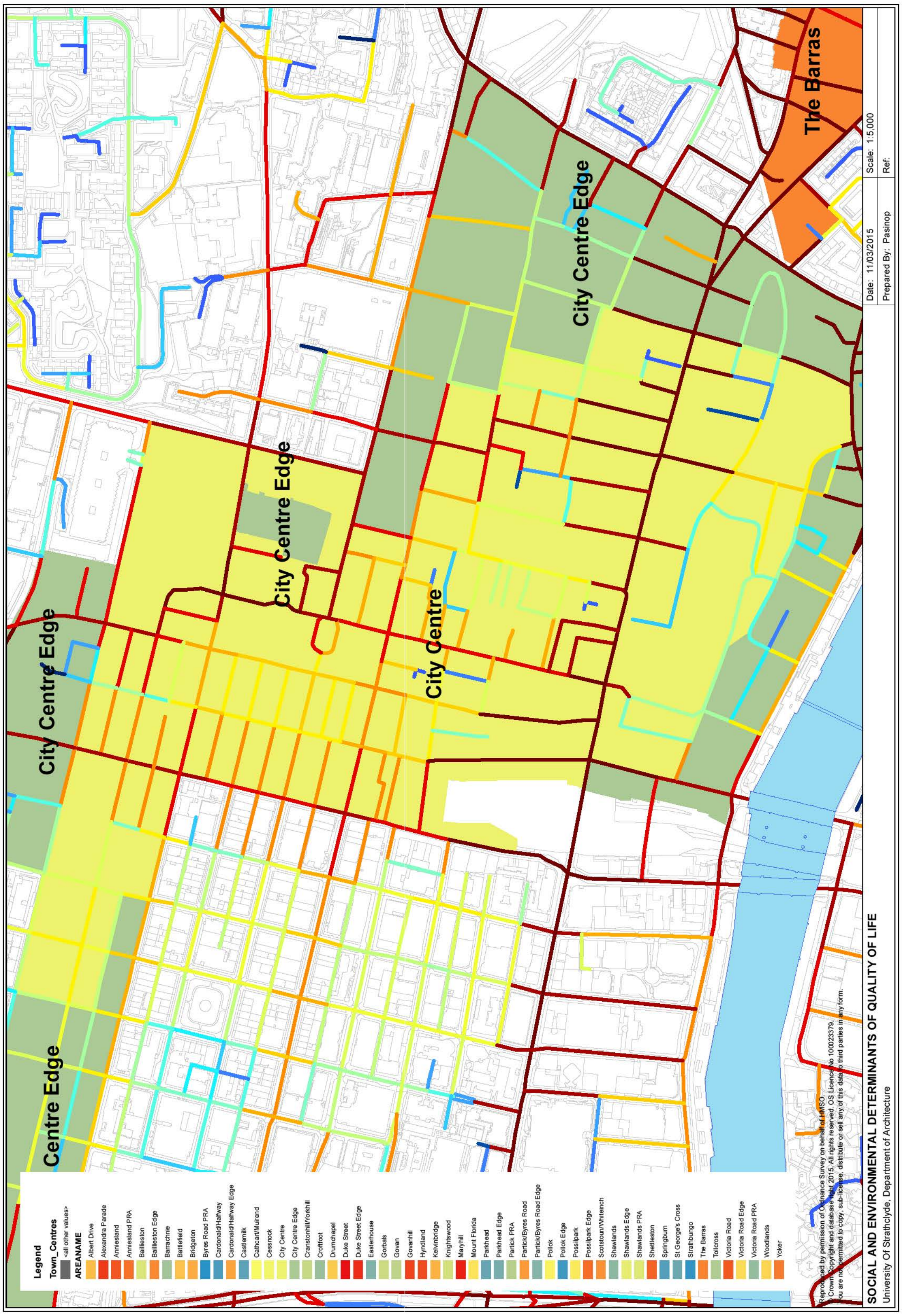


Figure 162. Betweenness Centrality Index. Town Centre: City Centre.pdf

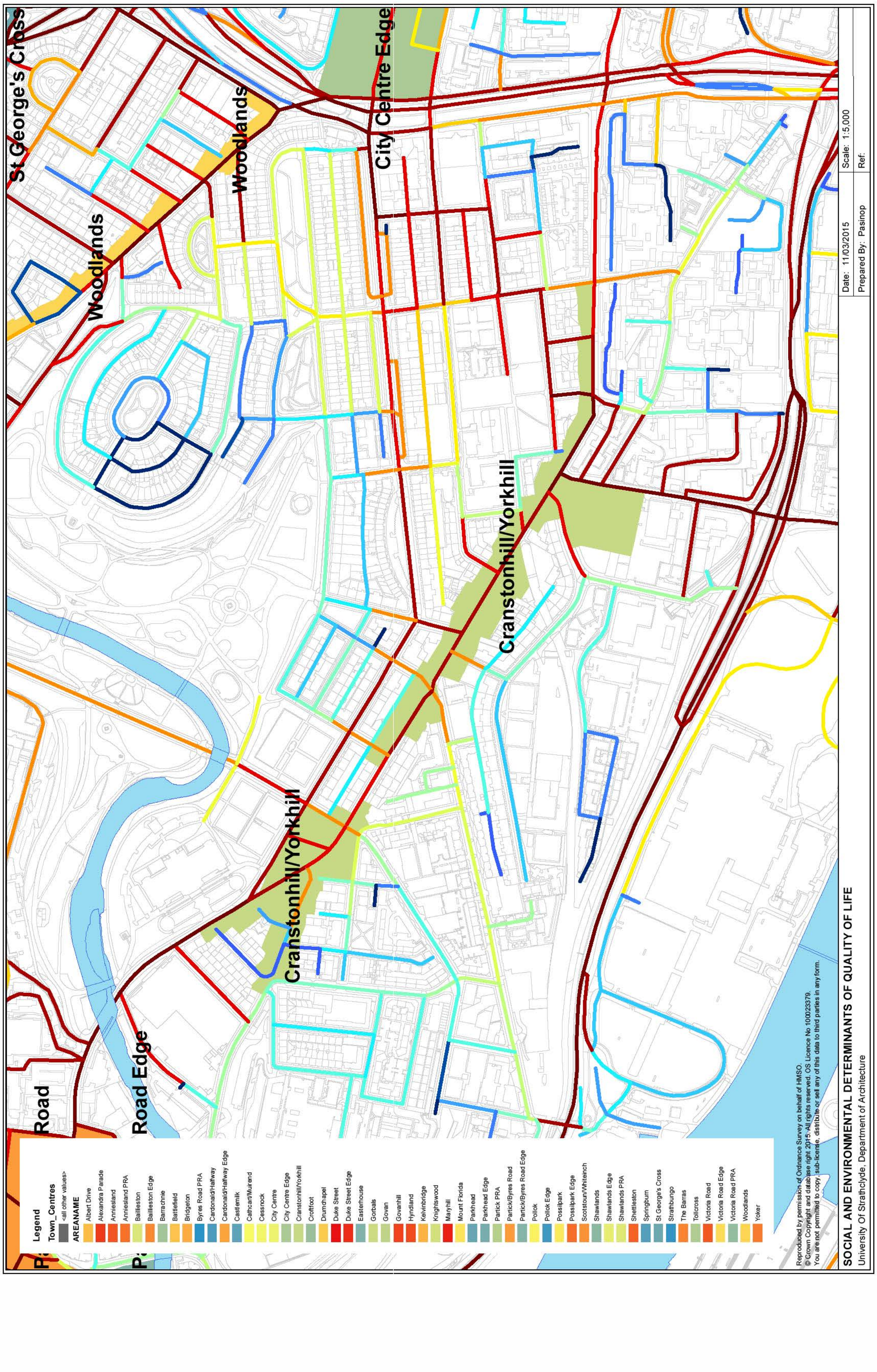


Figure 163. Betweenness Centrality Index. Town Centre: Cranstonhill_Yorkhill.pdf

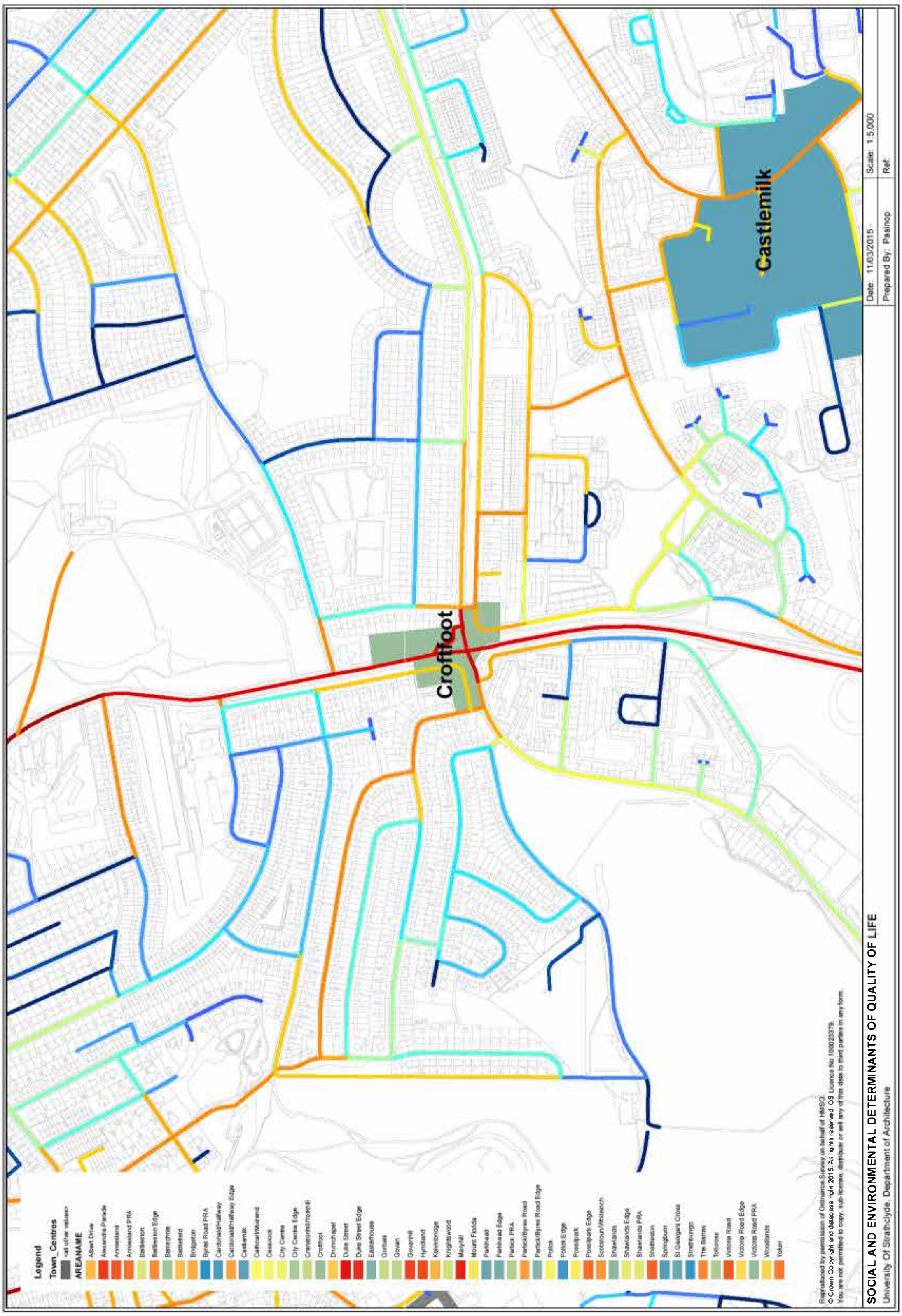


Figure 164. *Betweenness Centrality Index. Town Centre: Croftfoot.pdf*

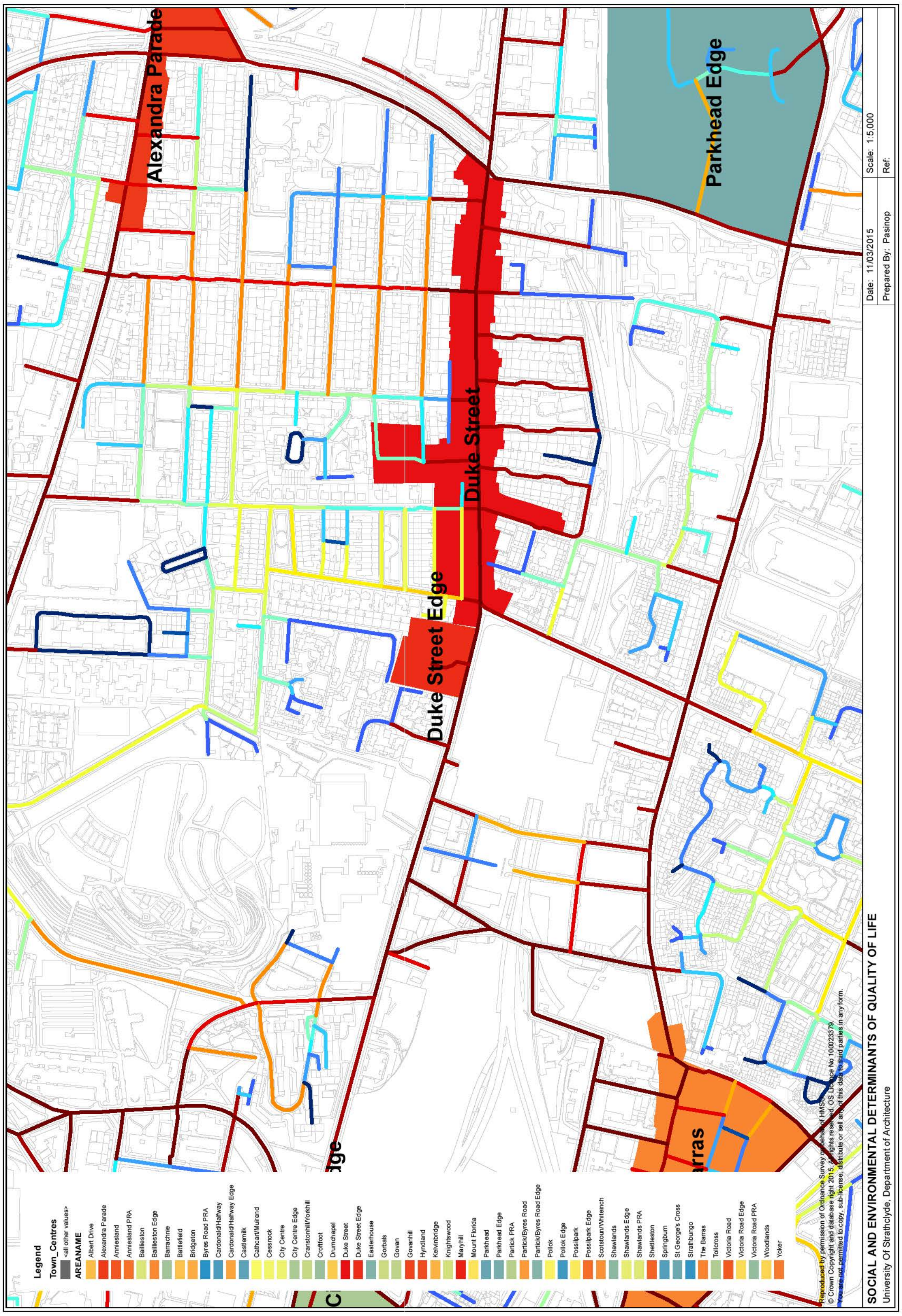


Figure 165. Betweenness Centrality Index. Town Centre: Duke Street Edge.pdf

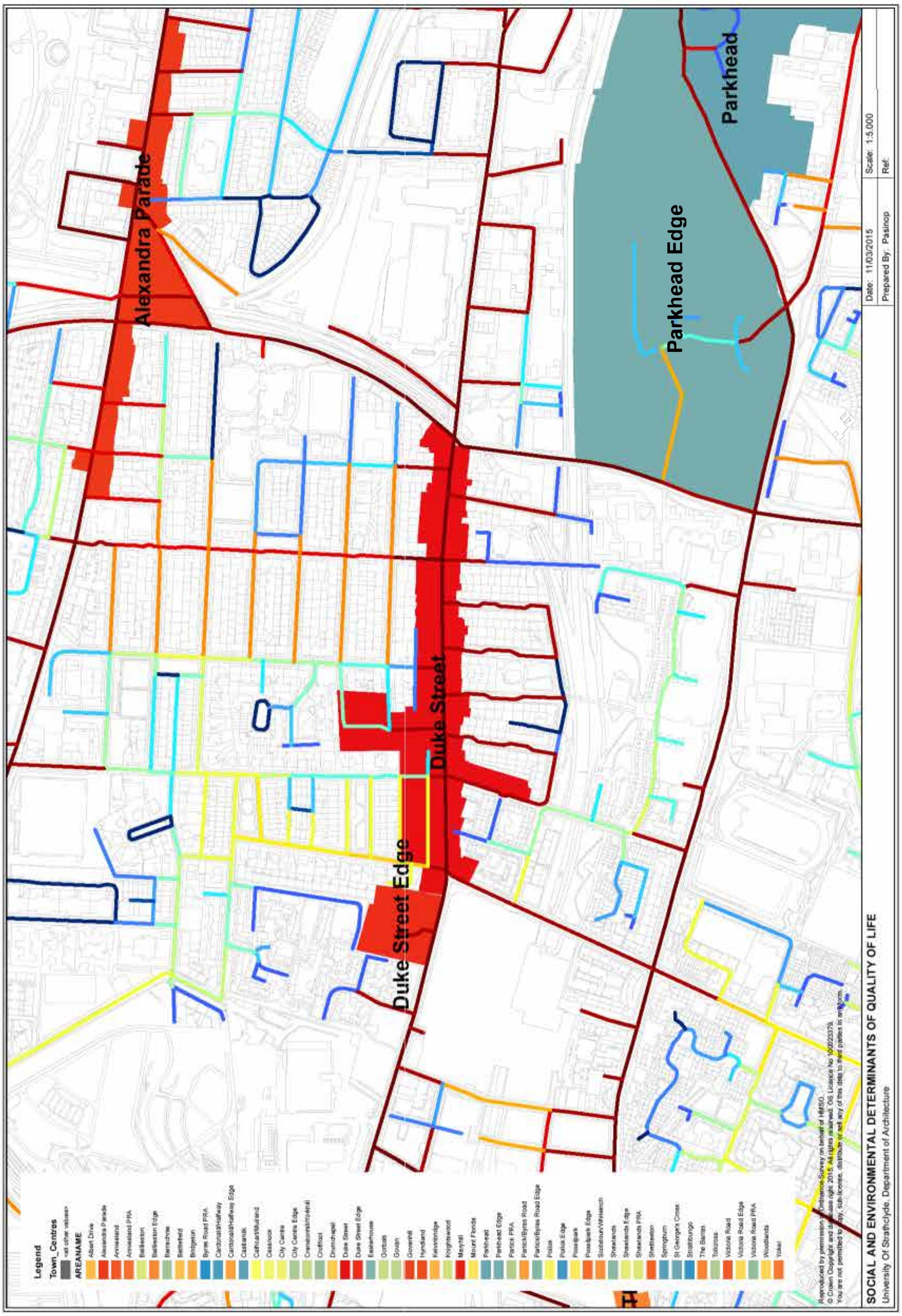


Figure 166. *Betweenness Centrality Index. Town Centre: Duke Street.pdf*

Figure 167. *Betweenness Centrality Index. Town Centre: Gorbals.pdf*

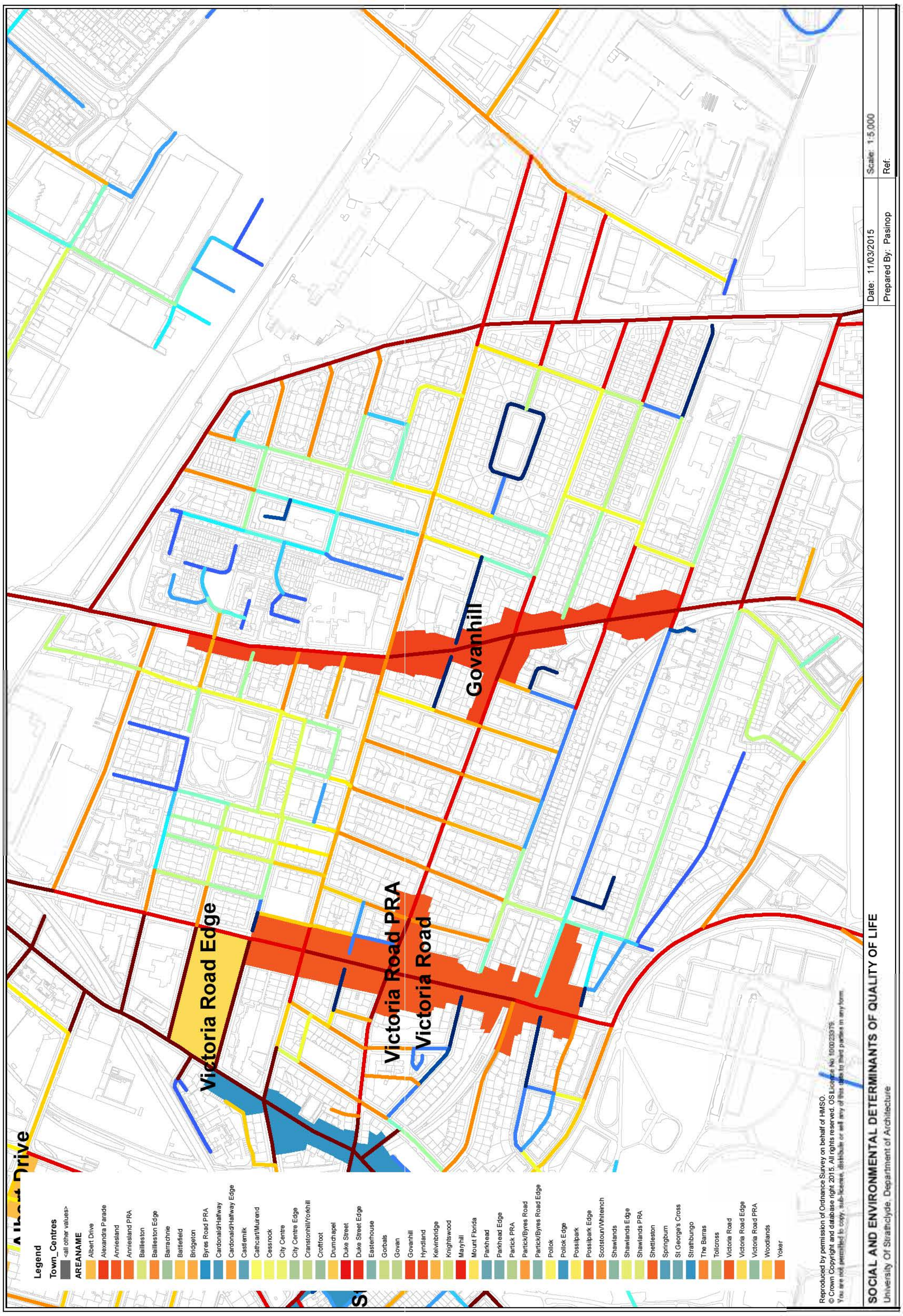


Figure 168. Betweenness Centrality Index. Town Centre: Govanhill.pdf

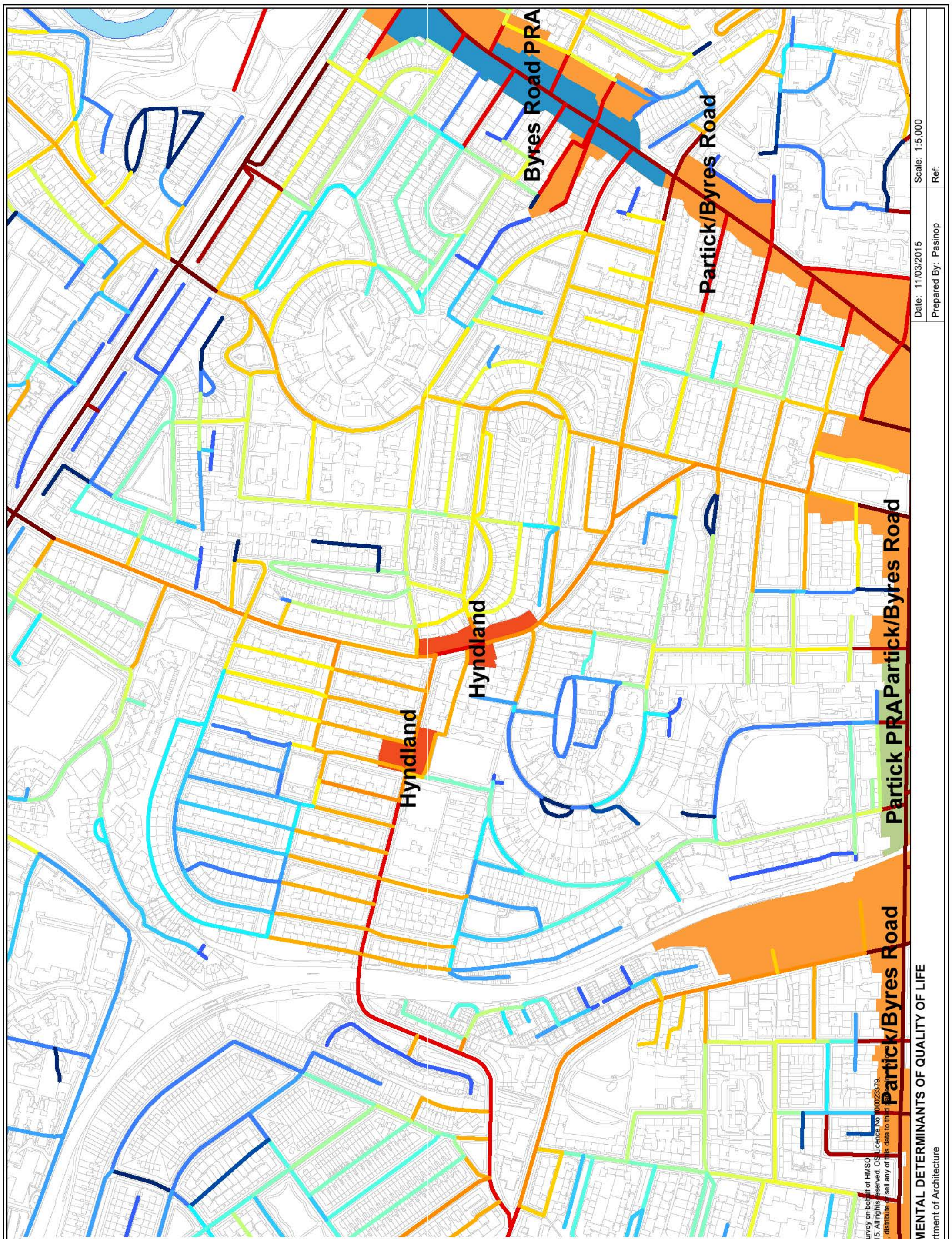


Figure 169. Betweenness Centrality Index. Town Centre: Hyndland.pdf

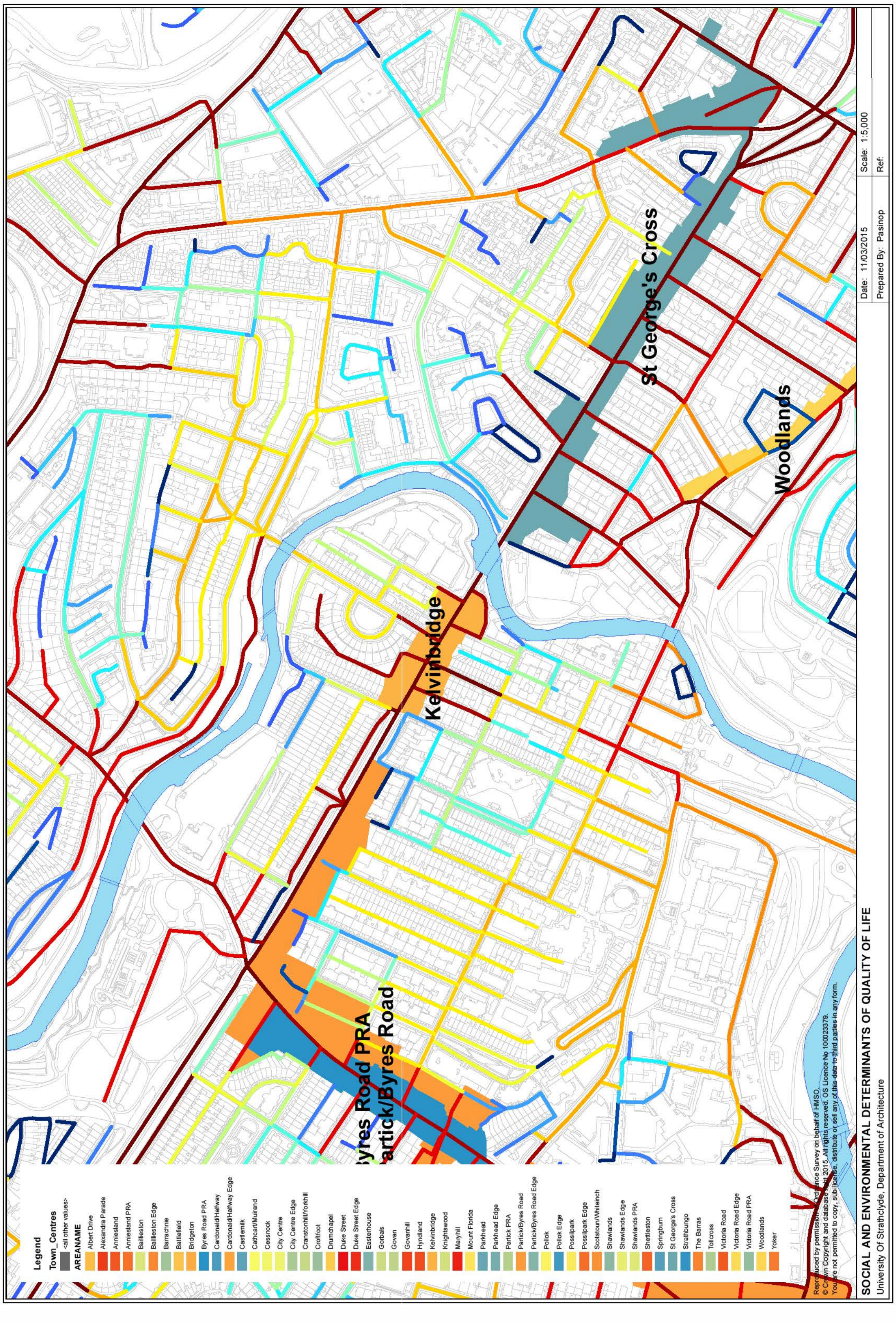


Figure 170. Betweenness Centrality Index. Town Centre: Kelvinbridge.pdf

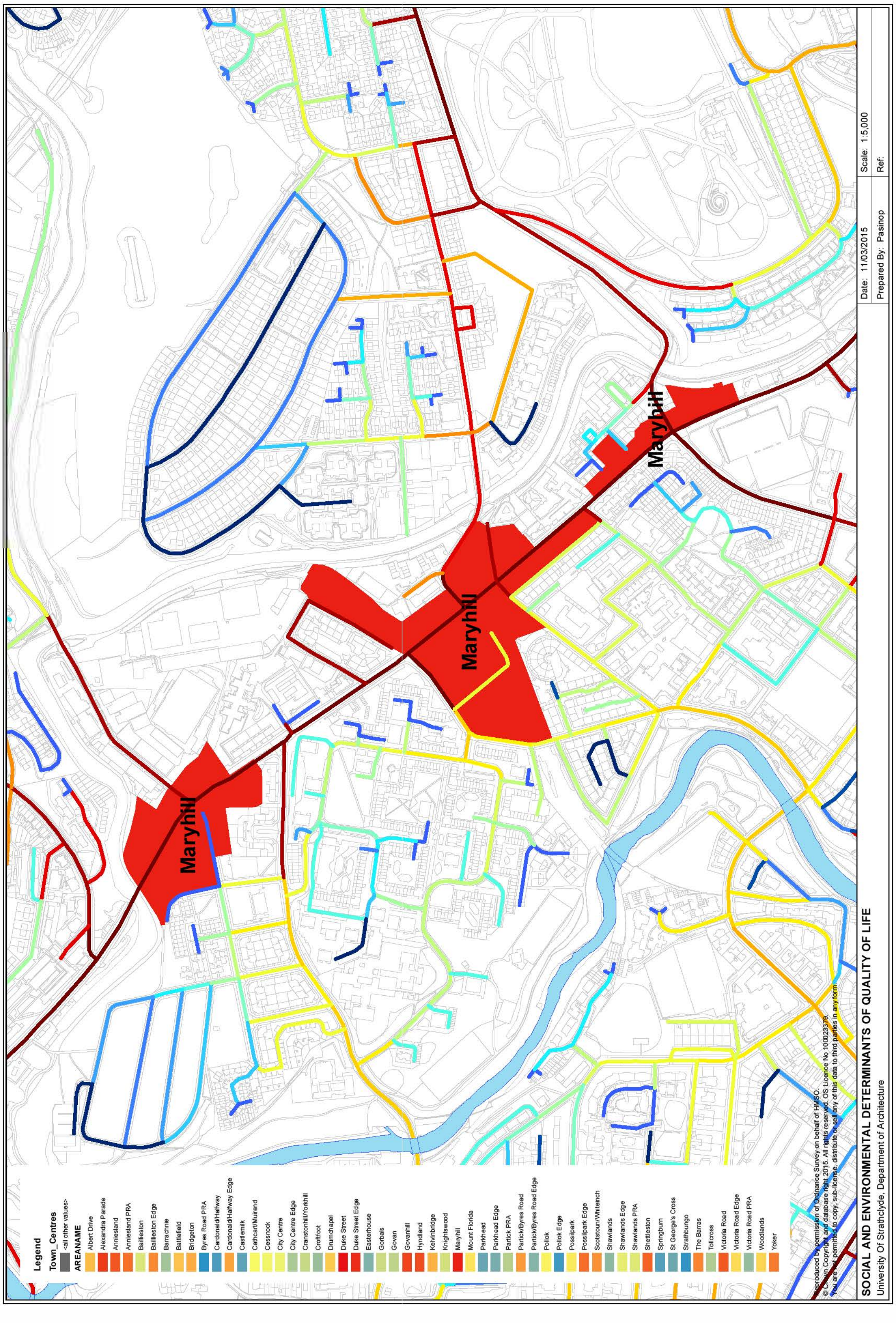


Figure 171. Betweenness Centrality Index. Town Centre: Maryhill.pdf

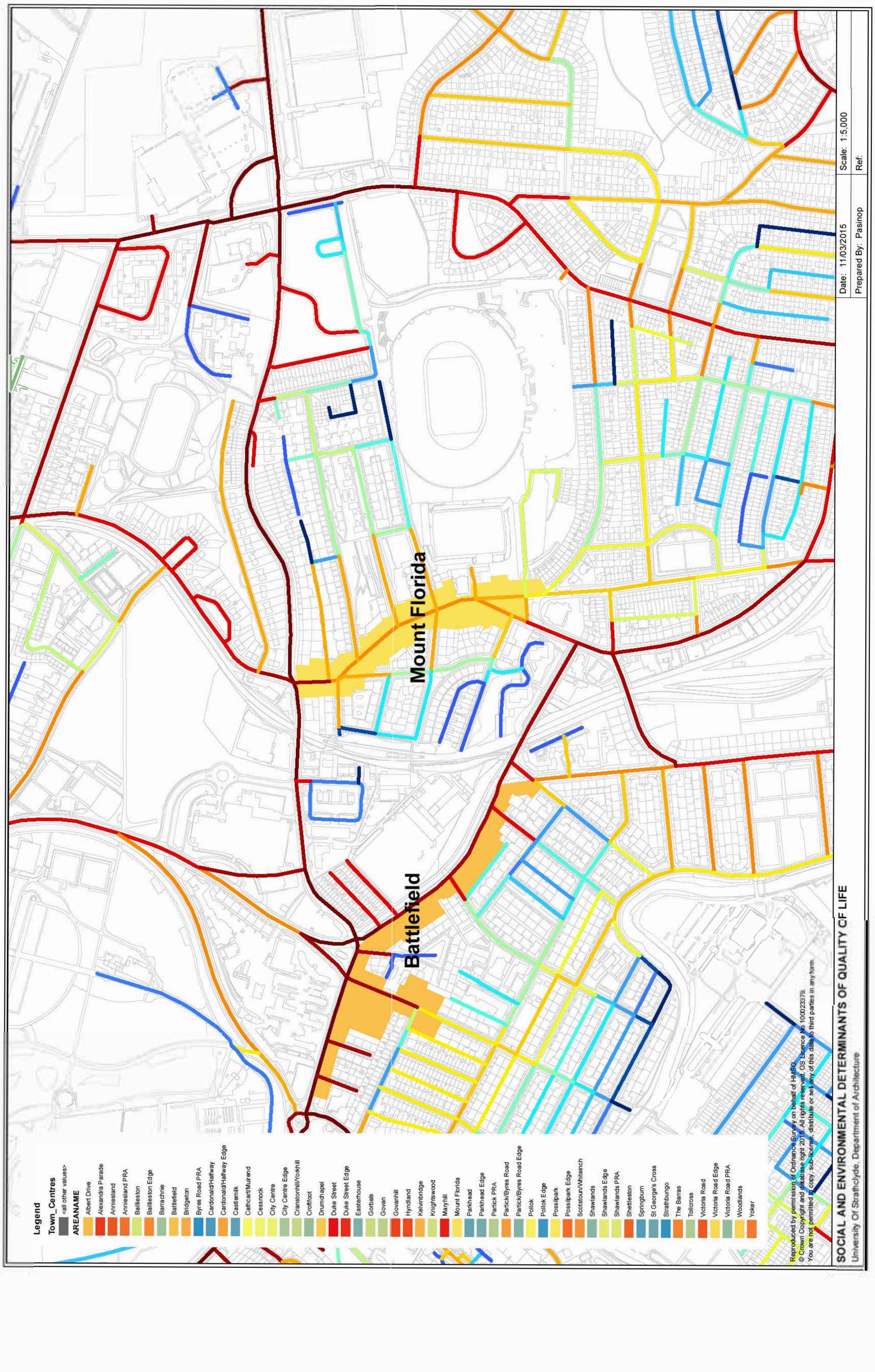


Figure 172. Betweenness Centrality Index. Town Centre: Mount Florida.pdf

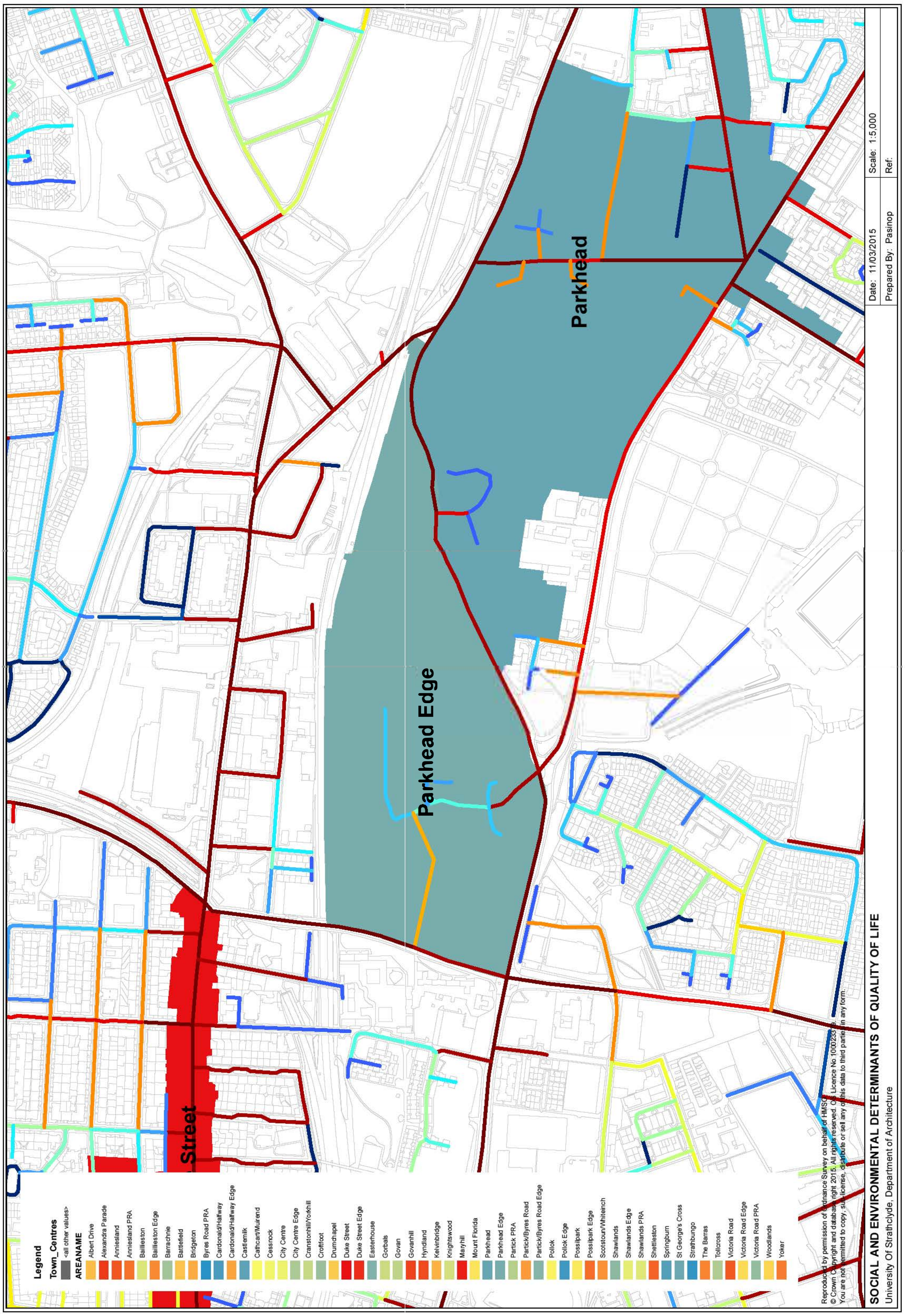


Figure 173. Betweenness Centrality Index. Town Centre: Parkhead Edge.pdf

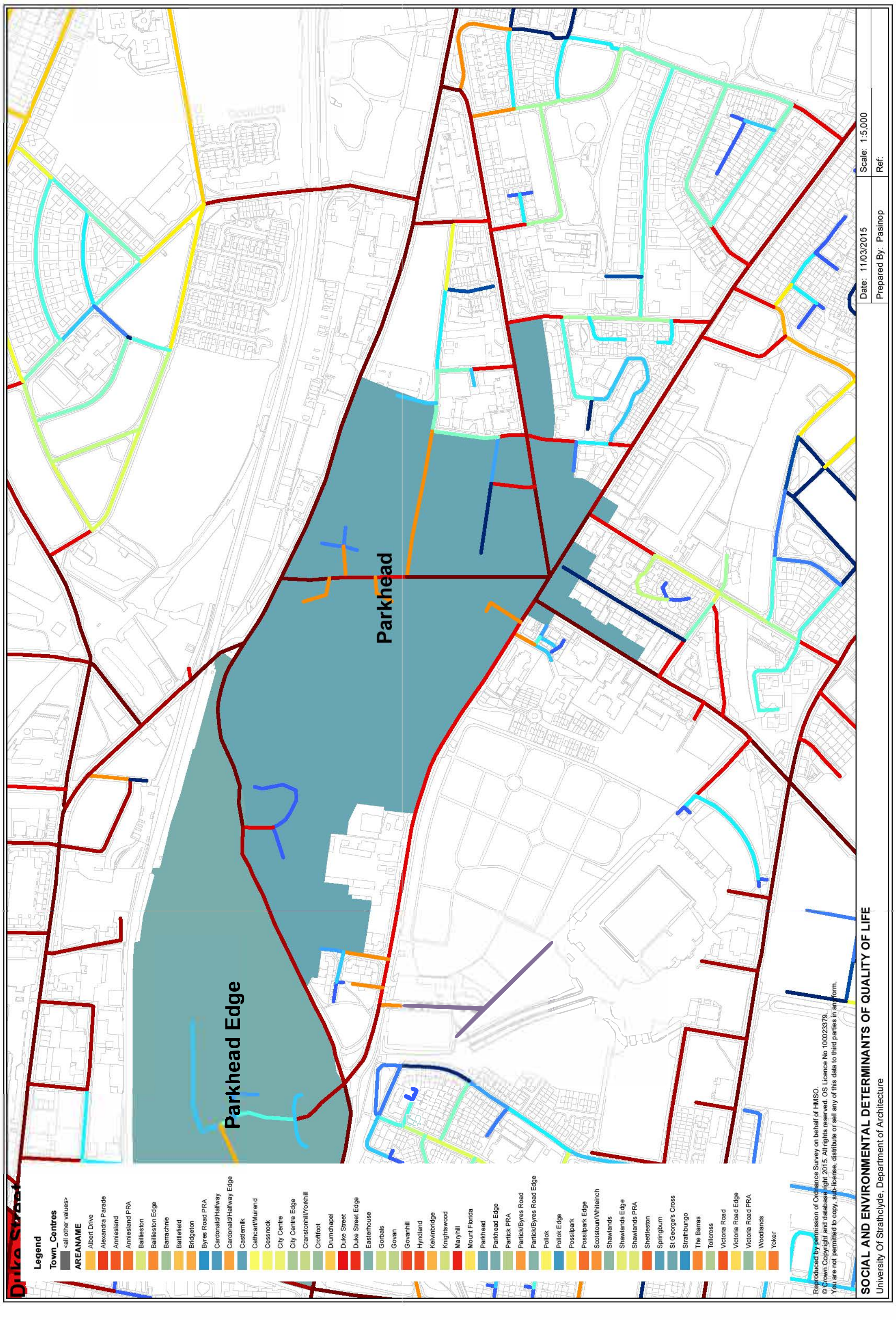


Figure 174. Betweenness Centrality Index. Town Centre: Parkhead.pdf

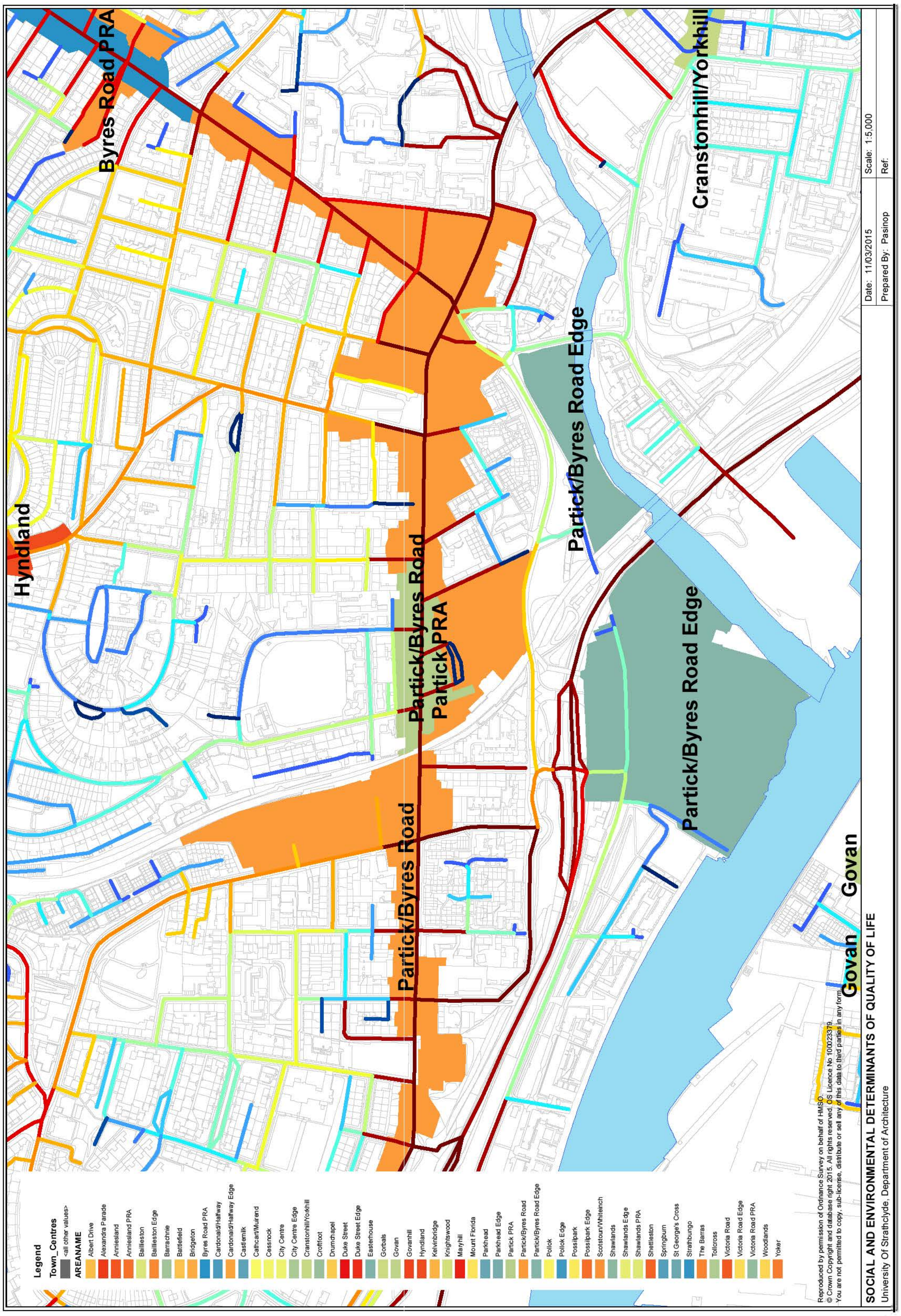


Figure 175. Betweenness Centrality Index. Town Centre: Partick PRA.pdf

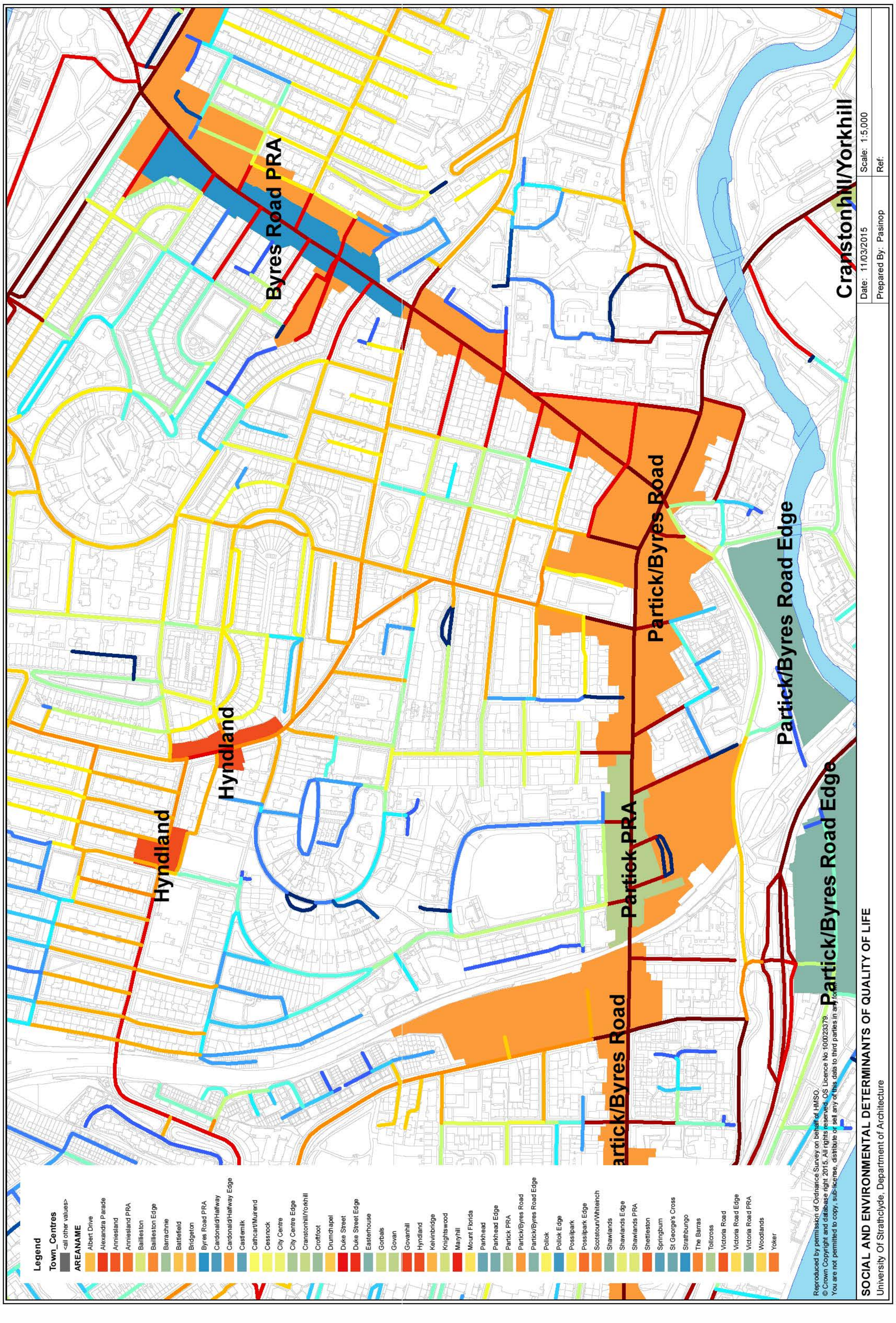


Figure 176. *Betweenness Centrality Index. Town Centre: Partick_Byres Road.pdf*

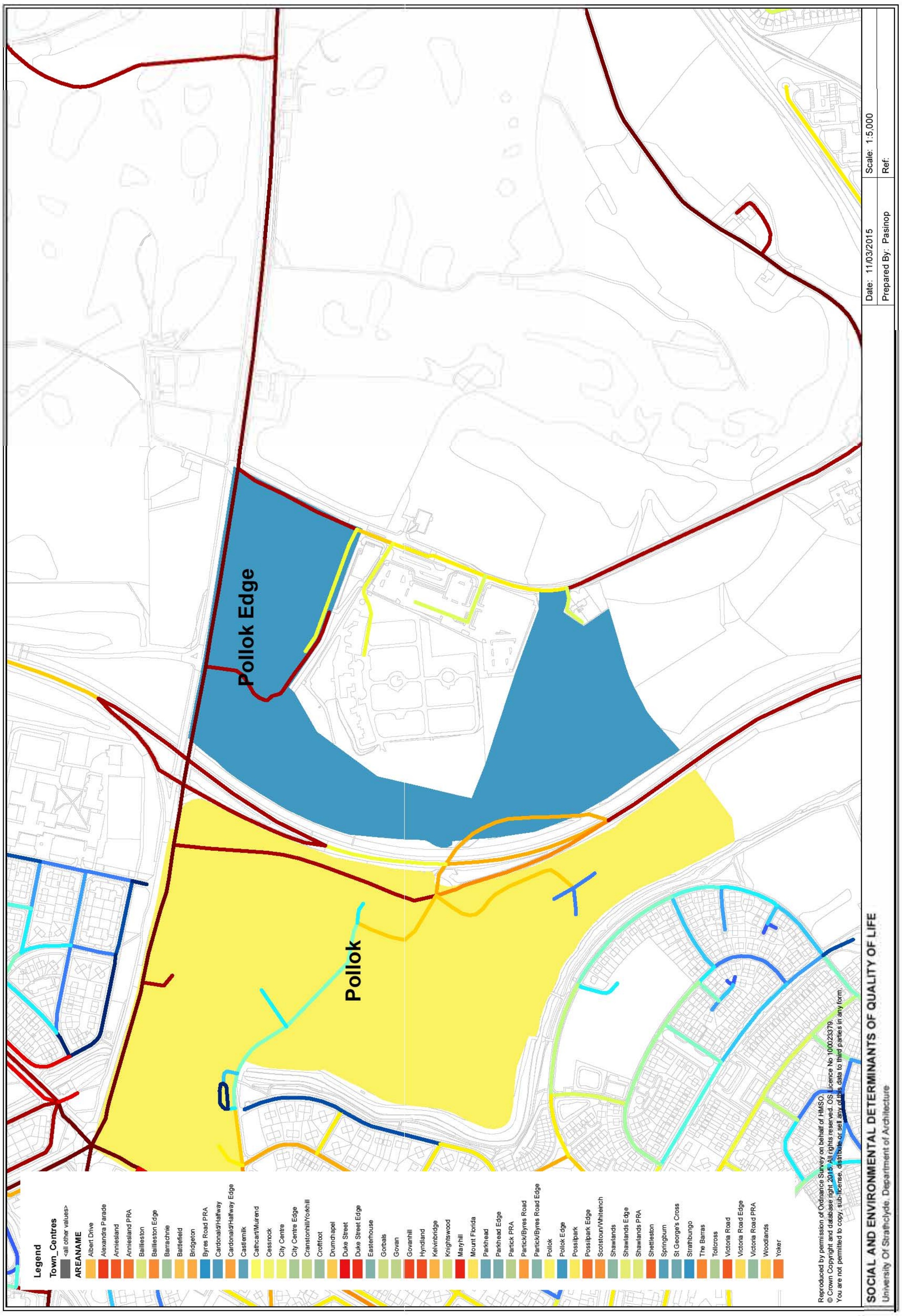


Figure 177. Betweenness Centrality Index. Town Centre: Pollok Edge.pdf

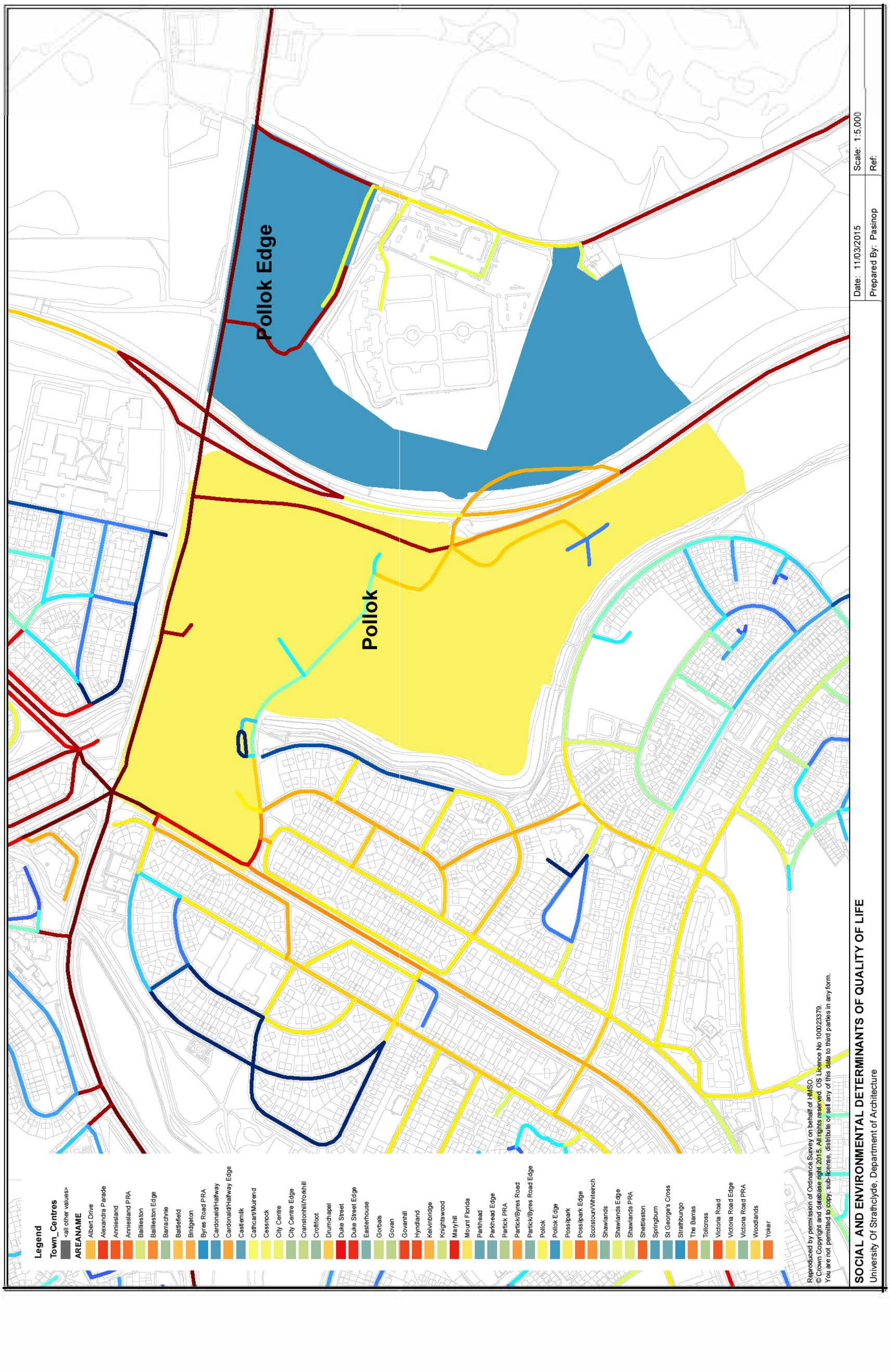


Figure 178. Betweenness Centrality Index. Town Centre: Pollok.pdf

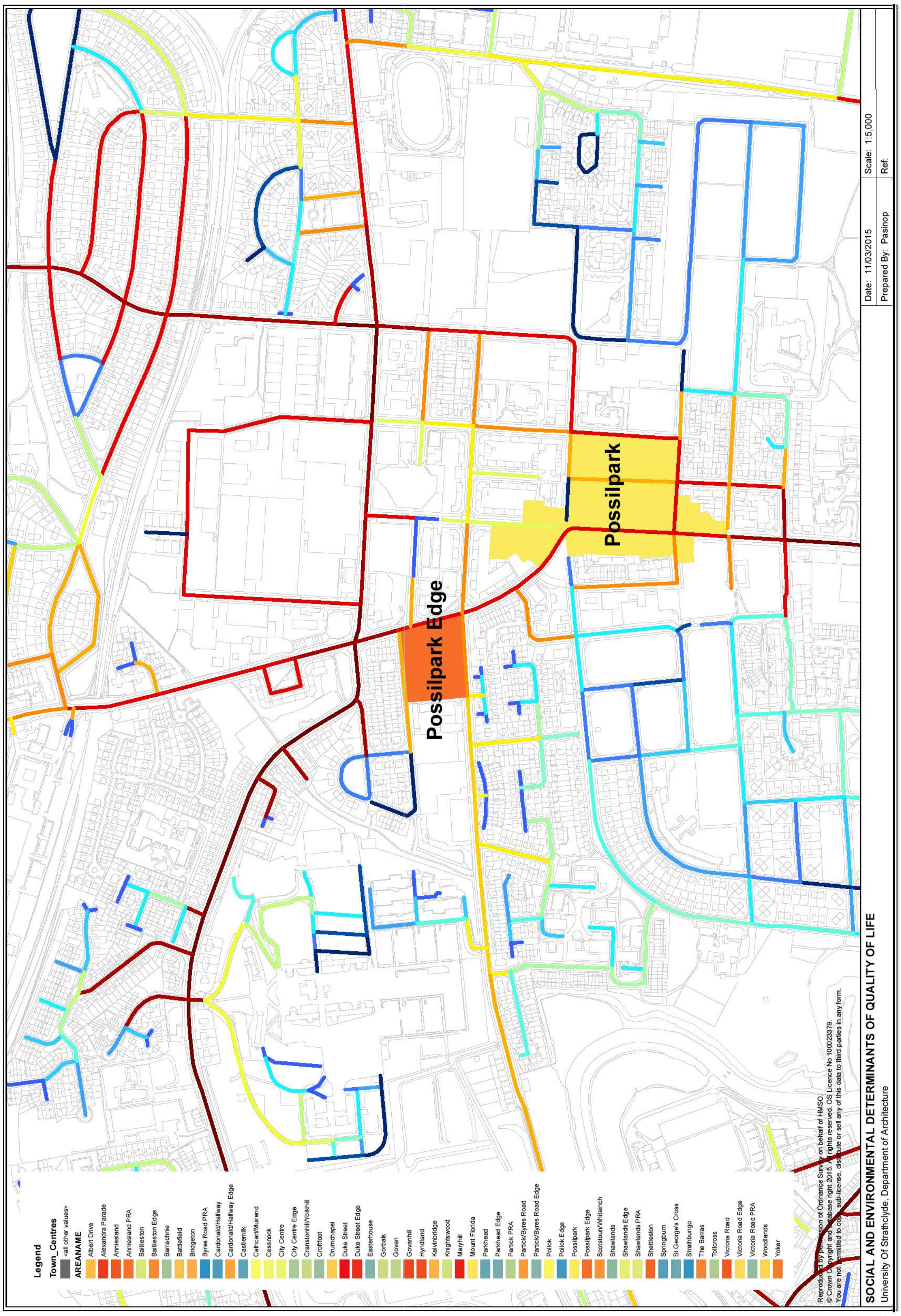


Figure 179. Betweenness Centrality Index. Town Centre: Possilpark Edge.pdf

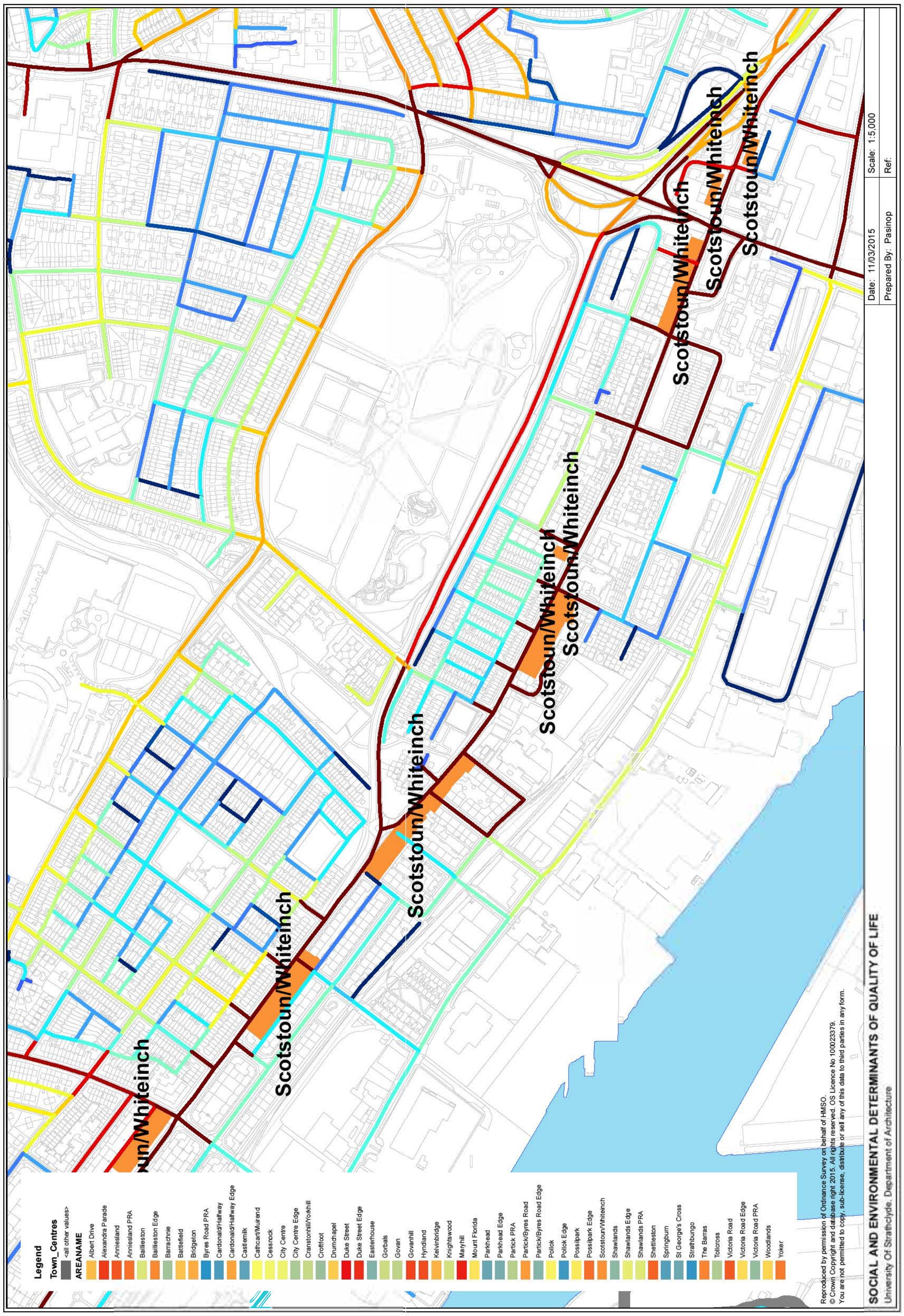


Figure 180. Betweenness Centrality Index. Town Centre: Scotstoun_Whiteinch.pdf

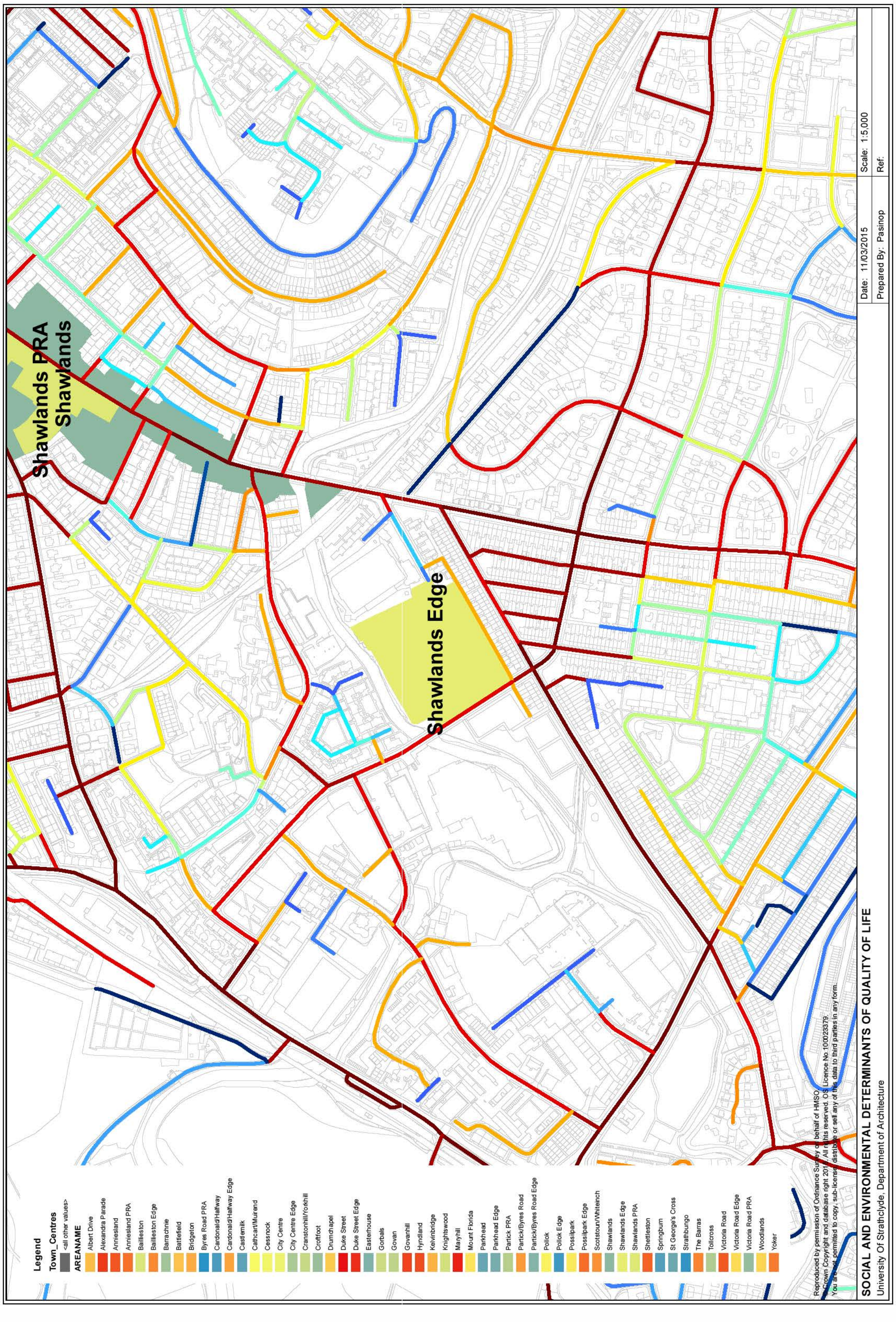


Figure 181. Betweenness Centrality Index. Town Centre: Shawlands Edge.pdf

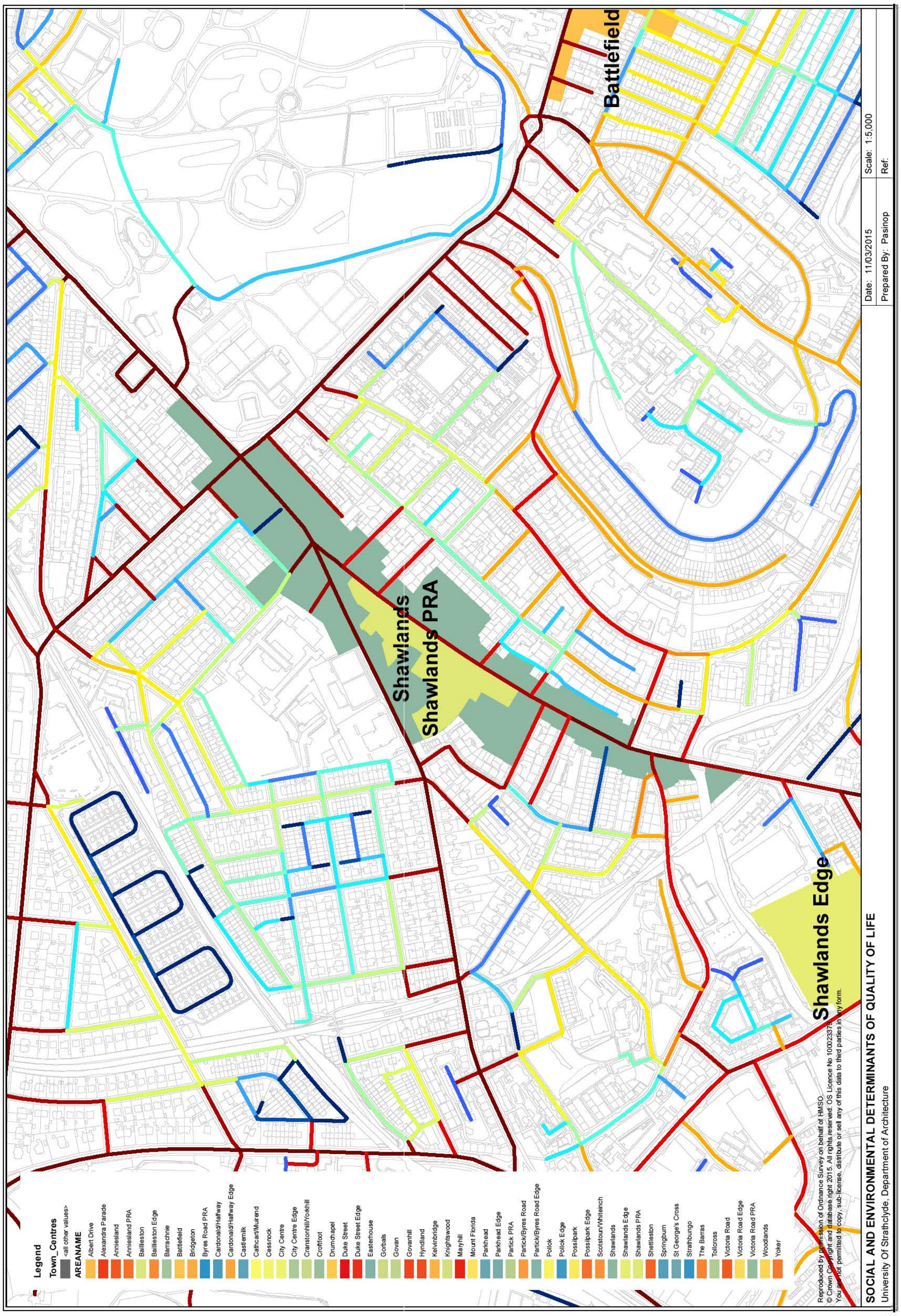


Figure 182. *Betweenness Centrality Index. Town Centre: Shawlands PRA.pdf*

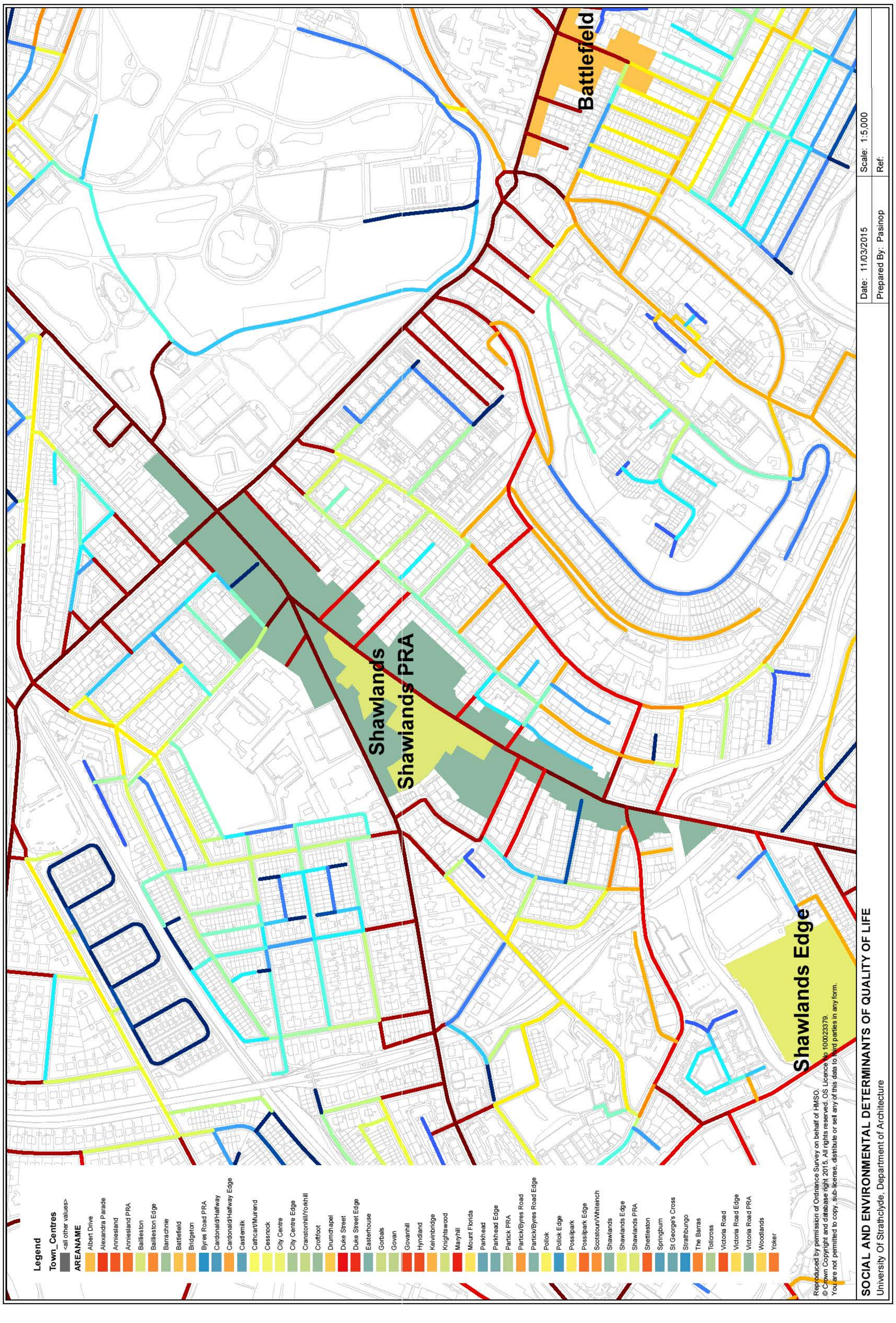


Figure 183. *Betweenness Centrality Index. Town Centre: Shawlands.pdf*

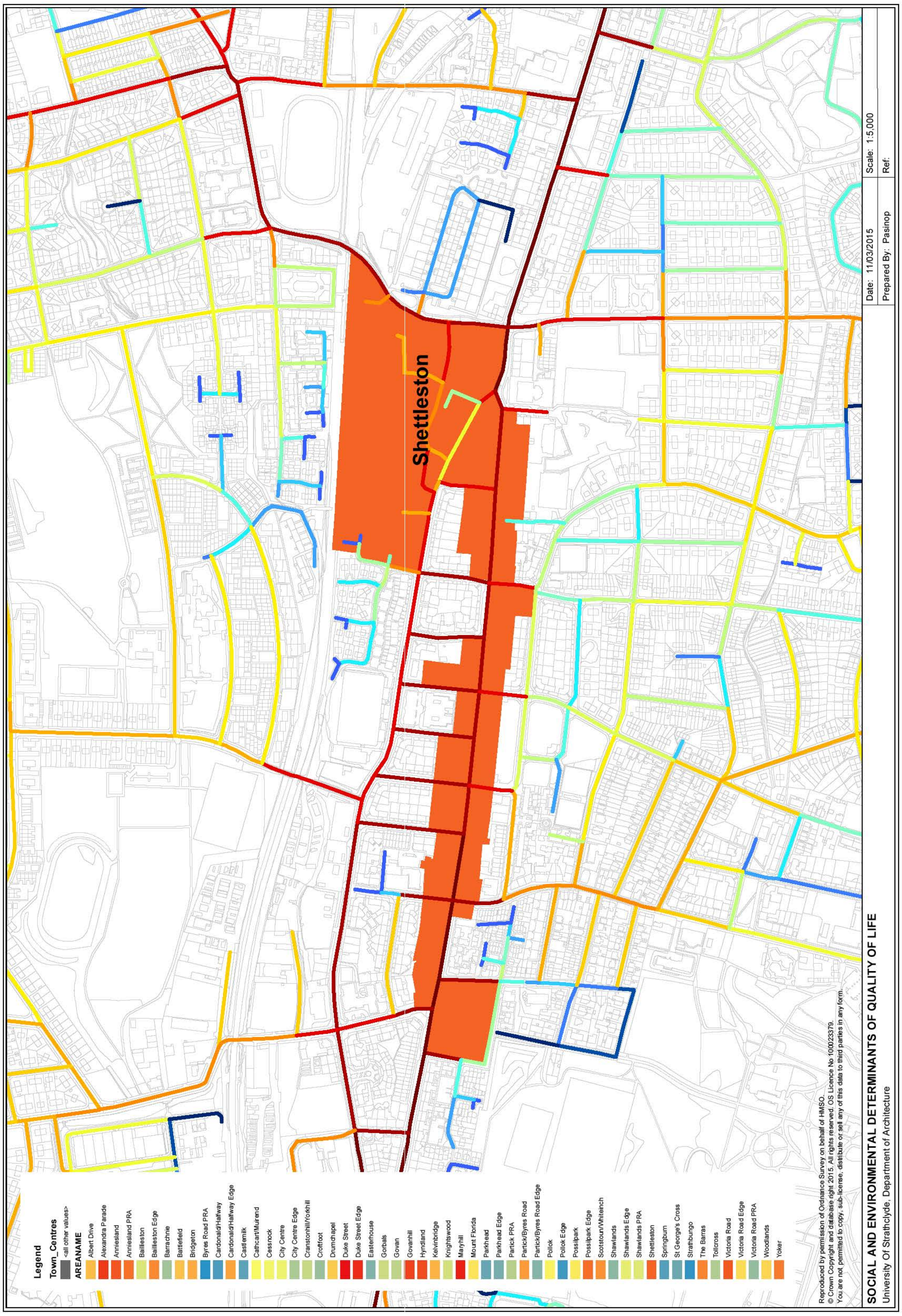


Figure 184. Betweenness Centrality Index. Town Centre: Shettleston.pdf

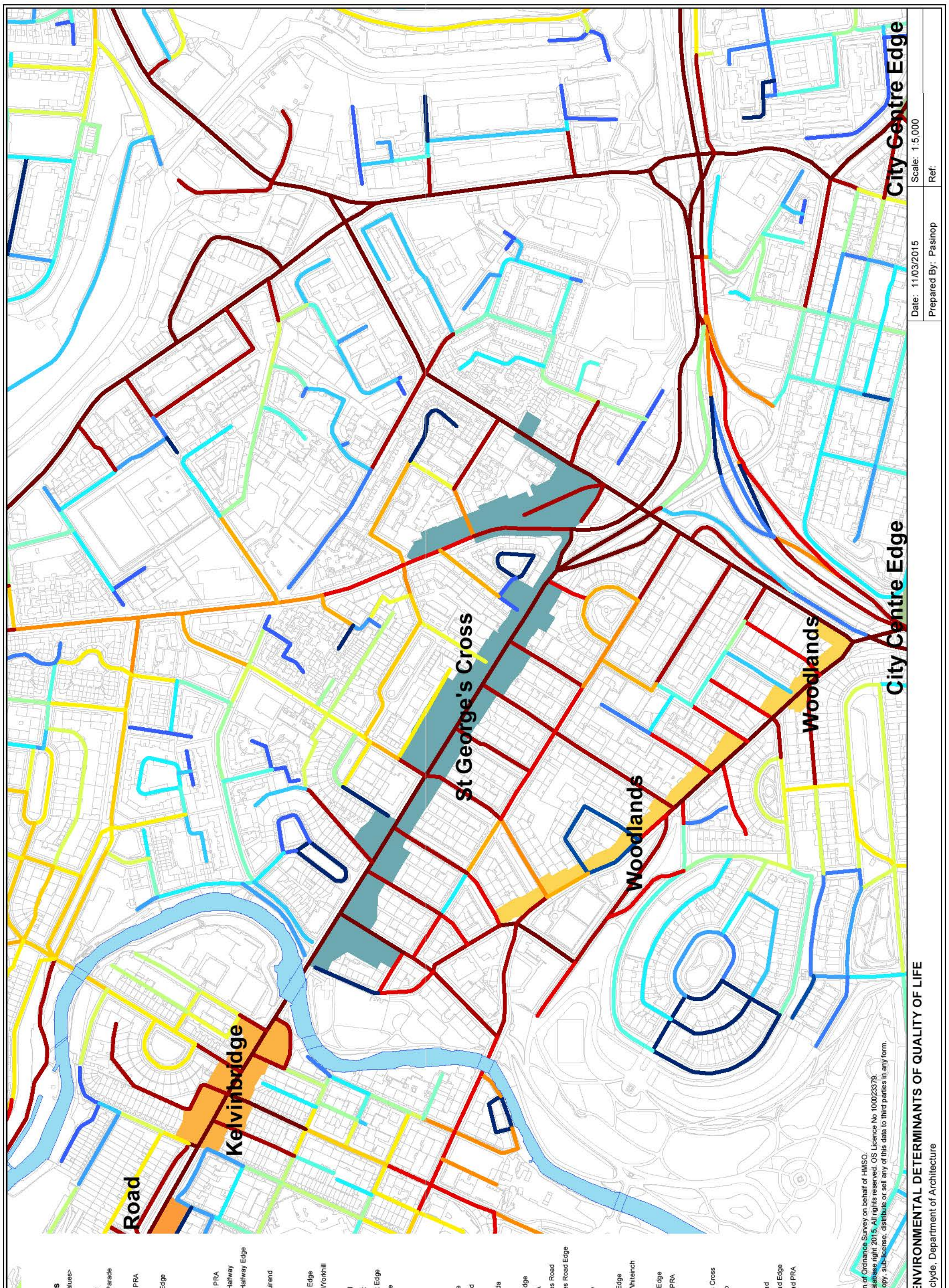


Figure 185. *Betweenness Centrality Index. Town Centre: St George's Cross.pdf*

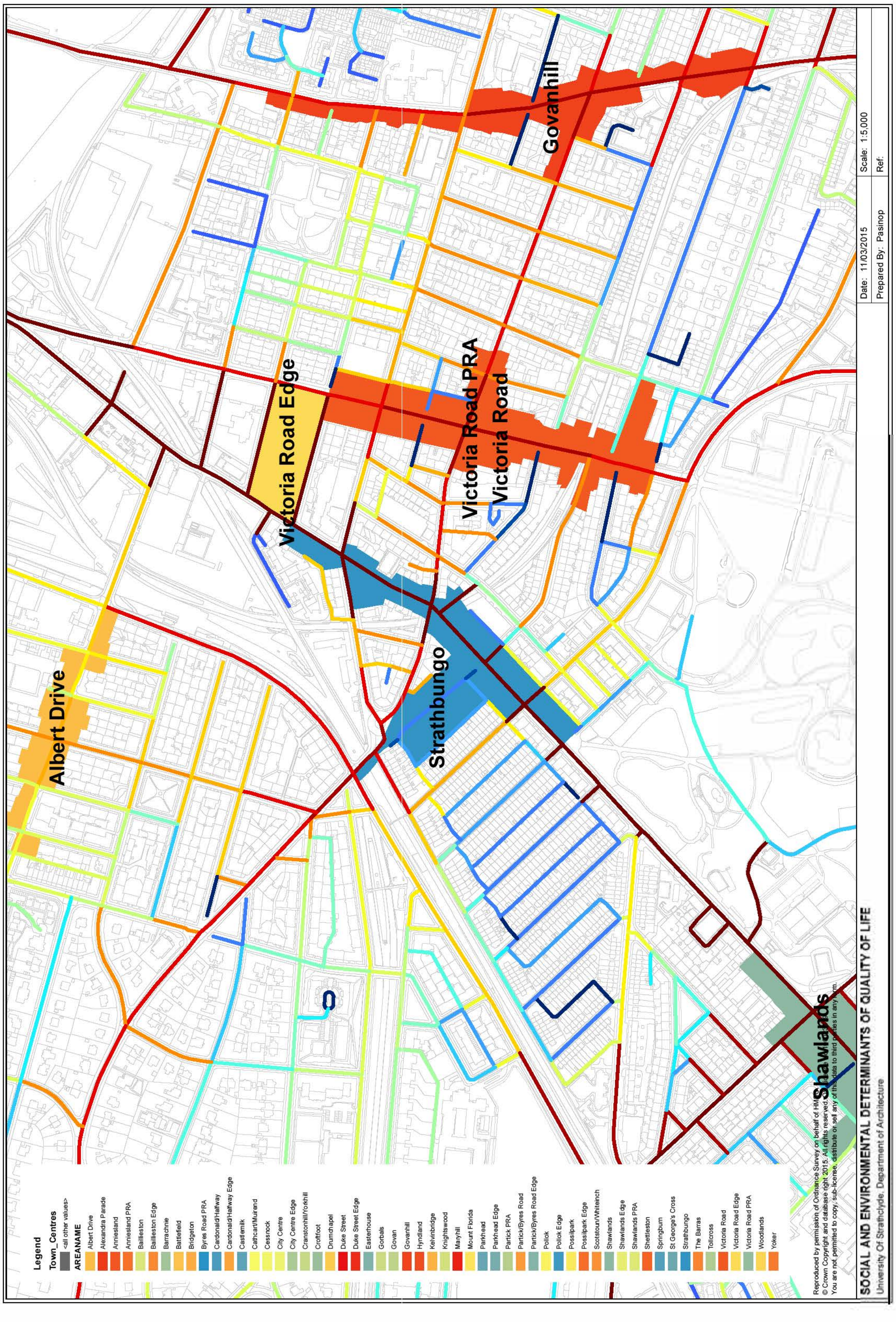


Figure 186. Betweenness Centrality Index. Town Centre: Strathbungo.pdf

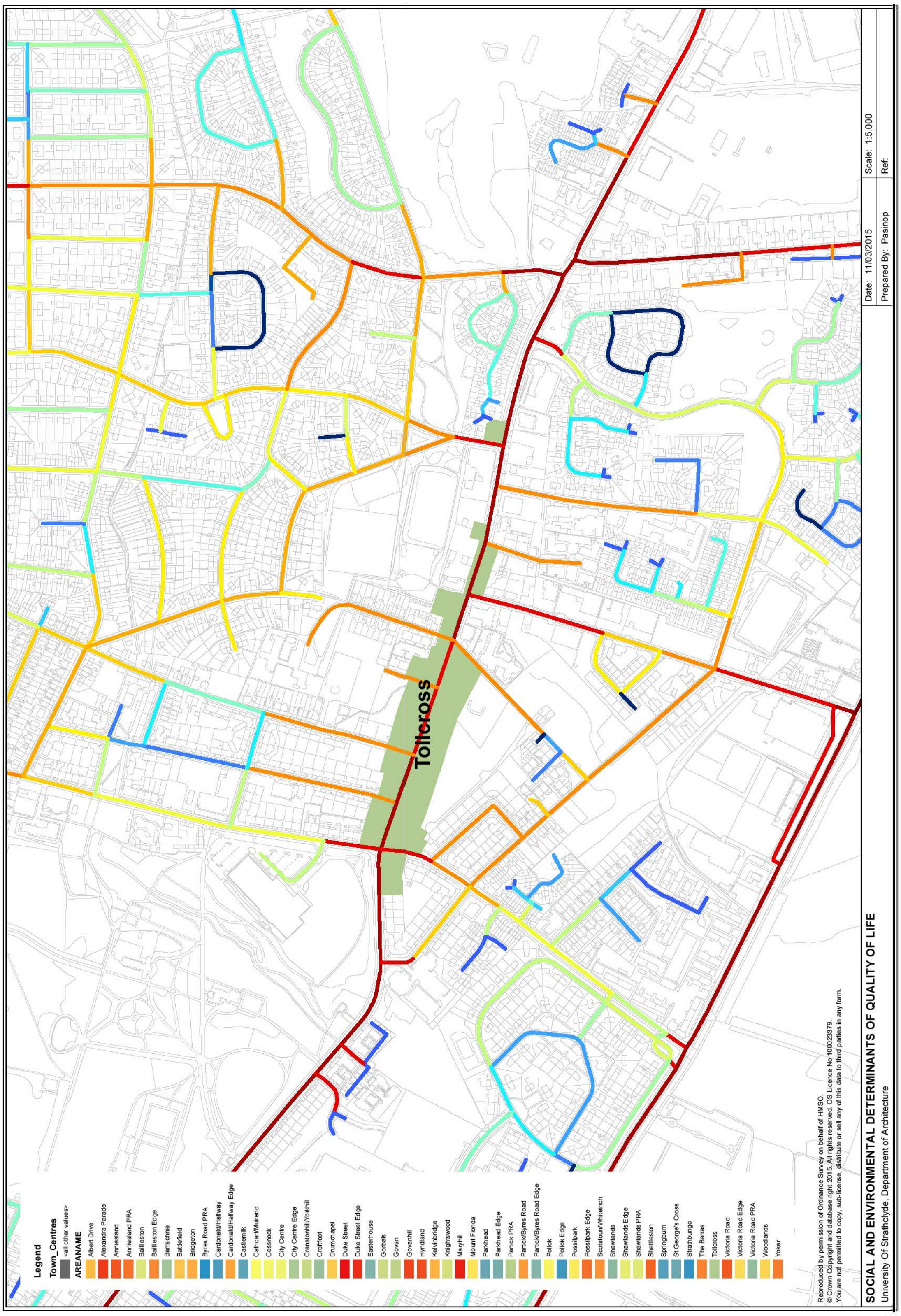


Figure 187. Betweenness Centrality Index. Town Centre: Tollcross.pdf

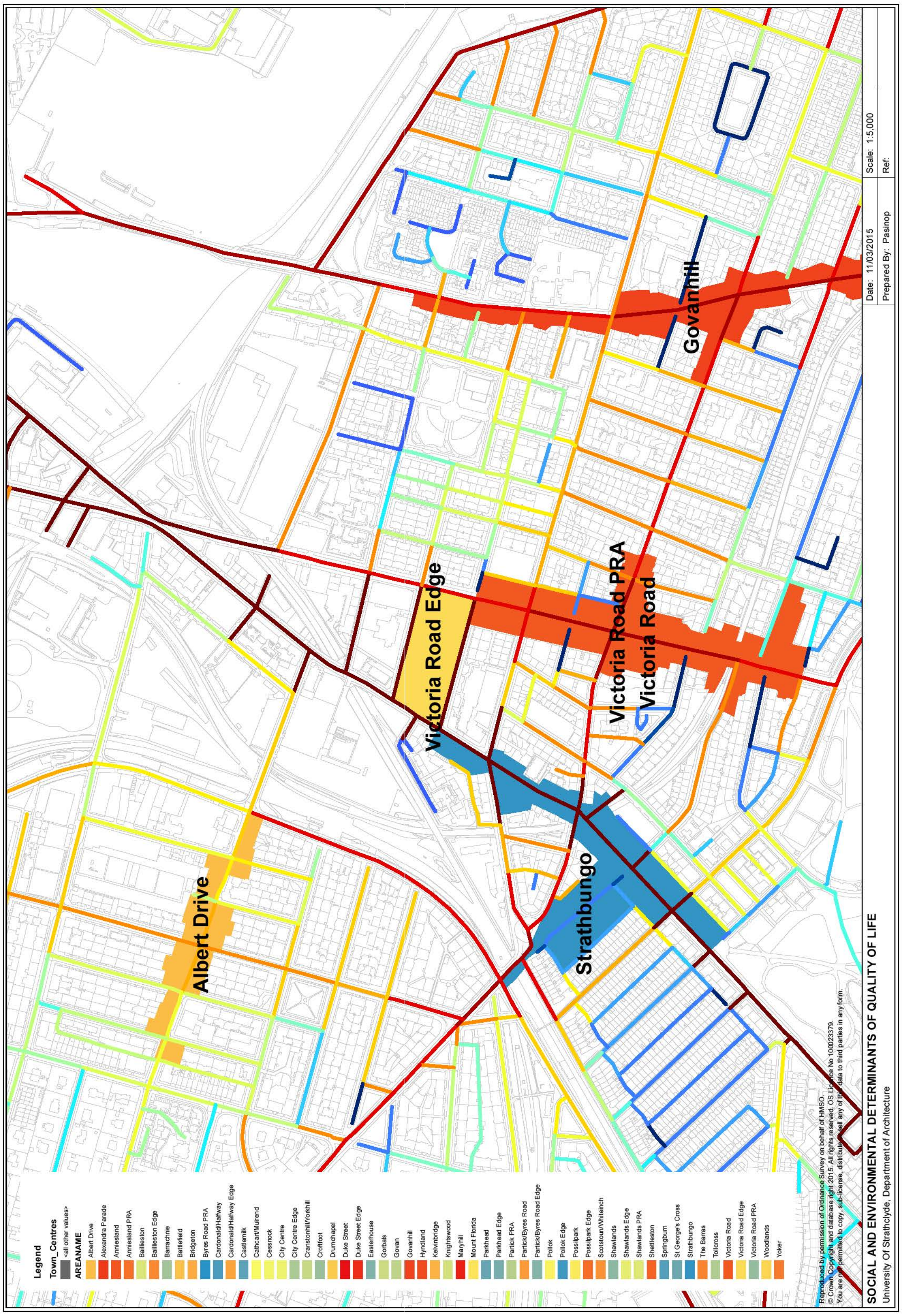


Figure 188. Betweenness Centrality Index. Town Centre: Victoria Road Edge.pdf

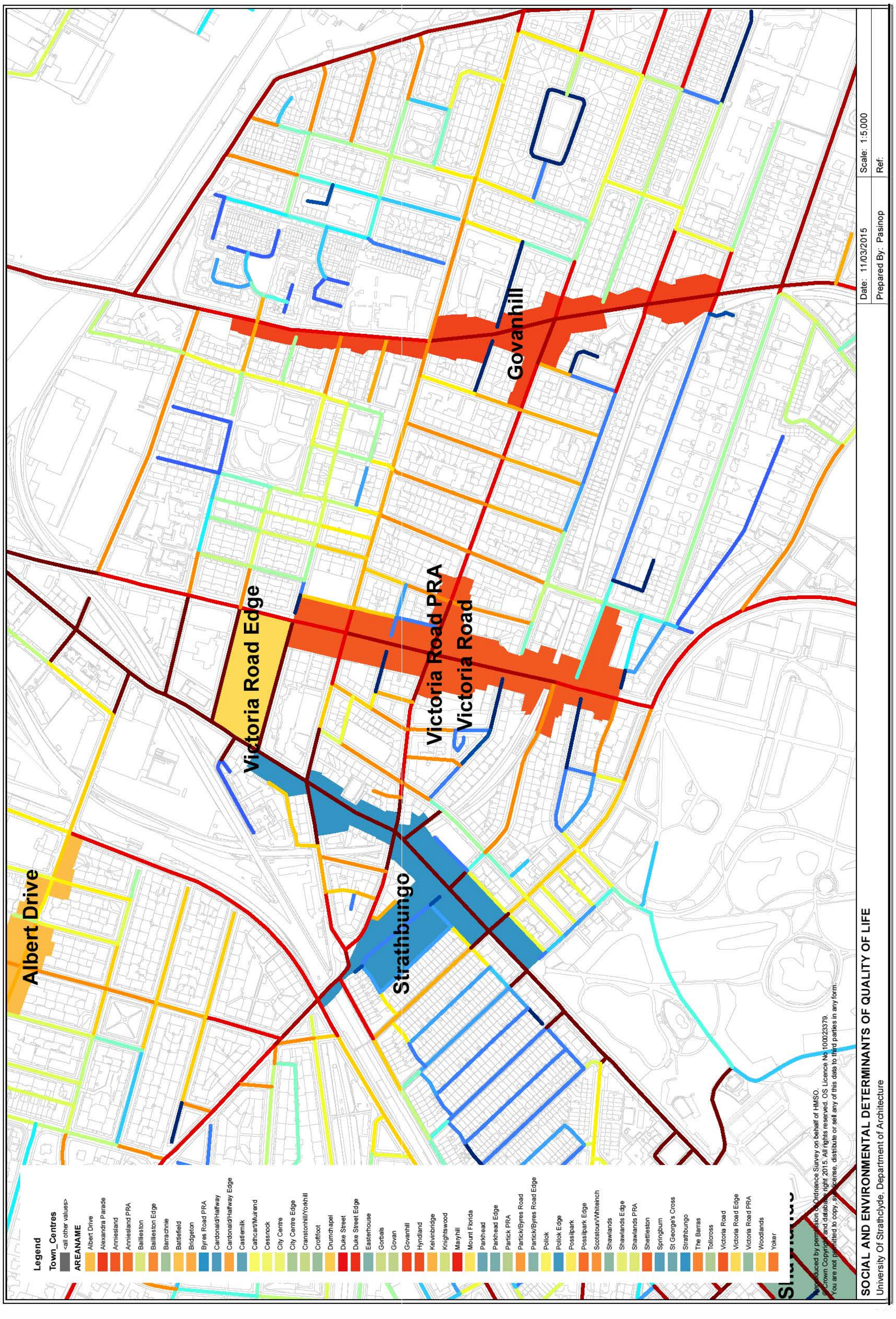


Figure 189. Betweenness Centrality Index. Town Centre: Victoria Road PRA.pdf

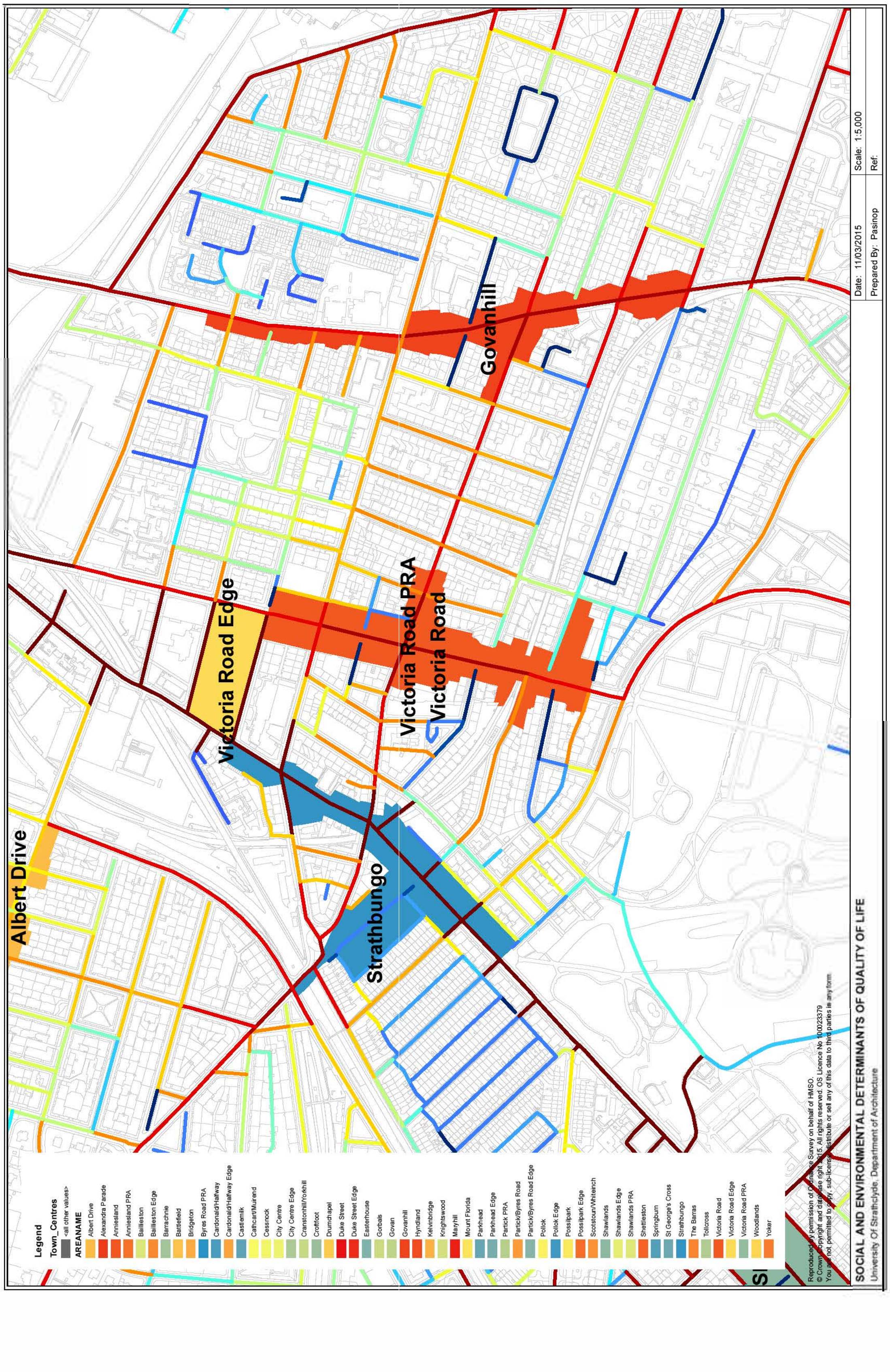


Figure 190. *Betweenness Centrality Index. Town Centre: Victoria Road.pdf*

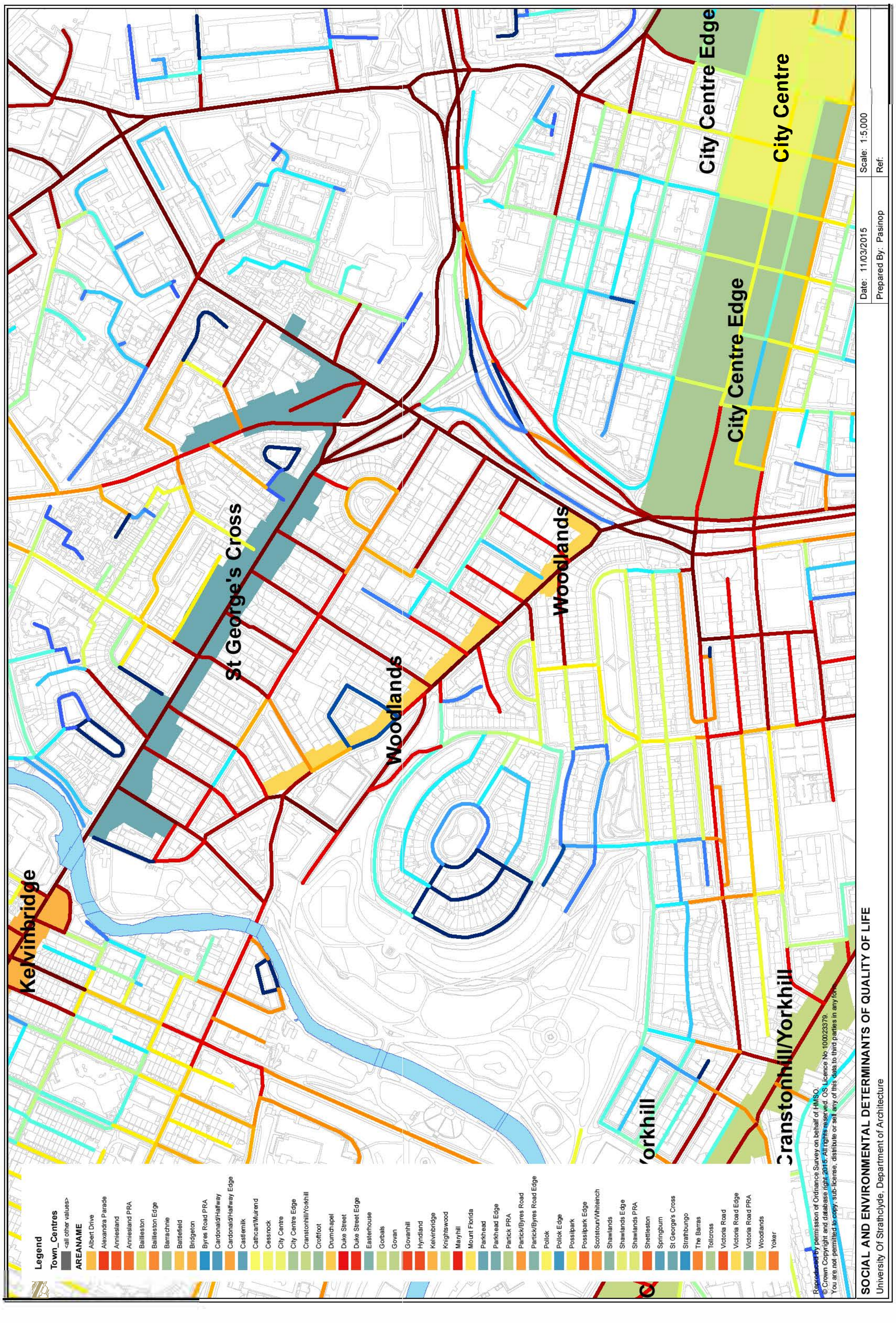


Figure 191. *Betweenness Centrality Index. Town Centre: Woodlands.pdf*

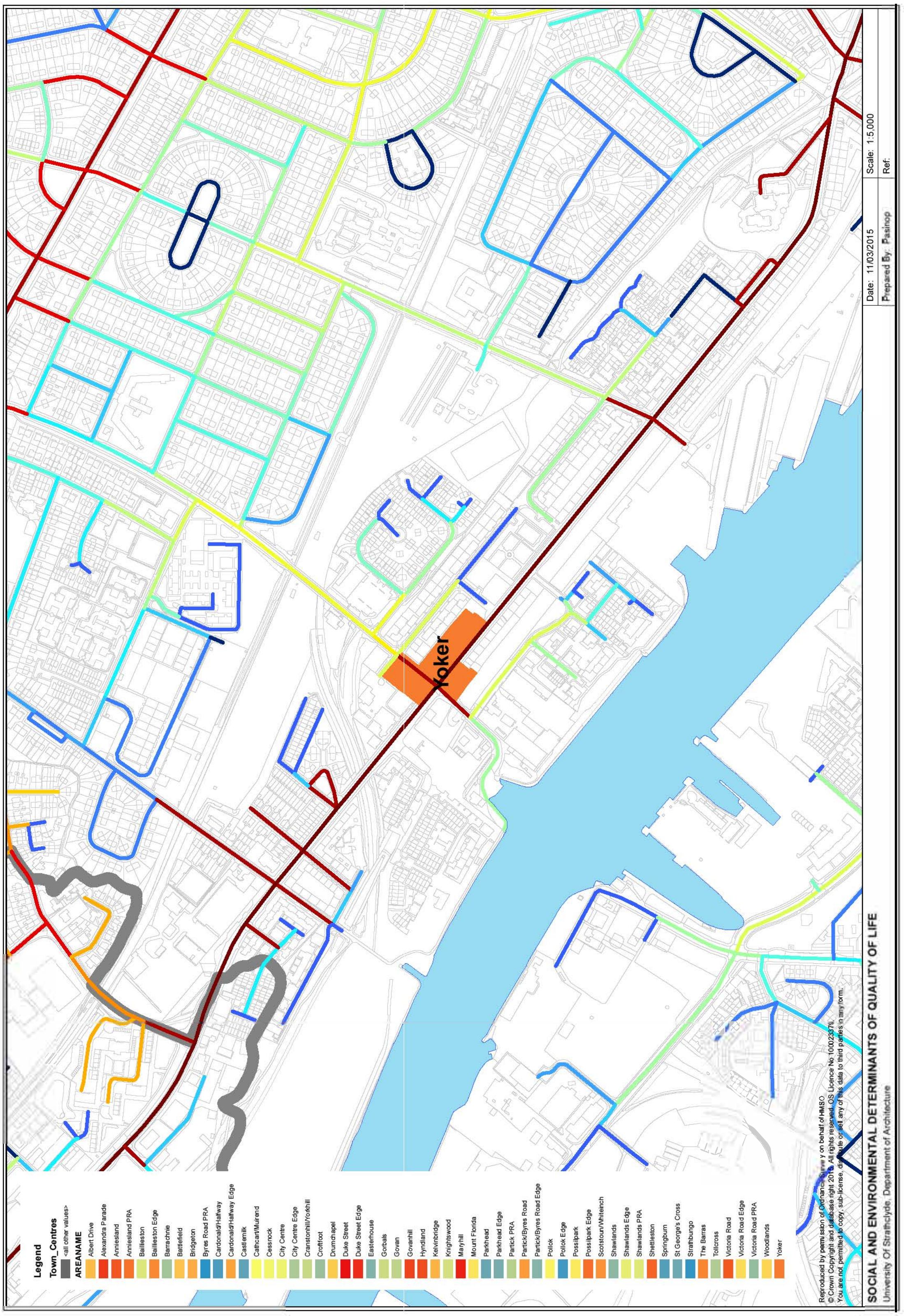


Figure 192. Betweenness Centrality Index. Town Centre: Yoker.pdf

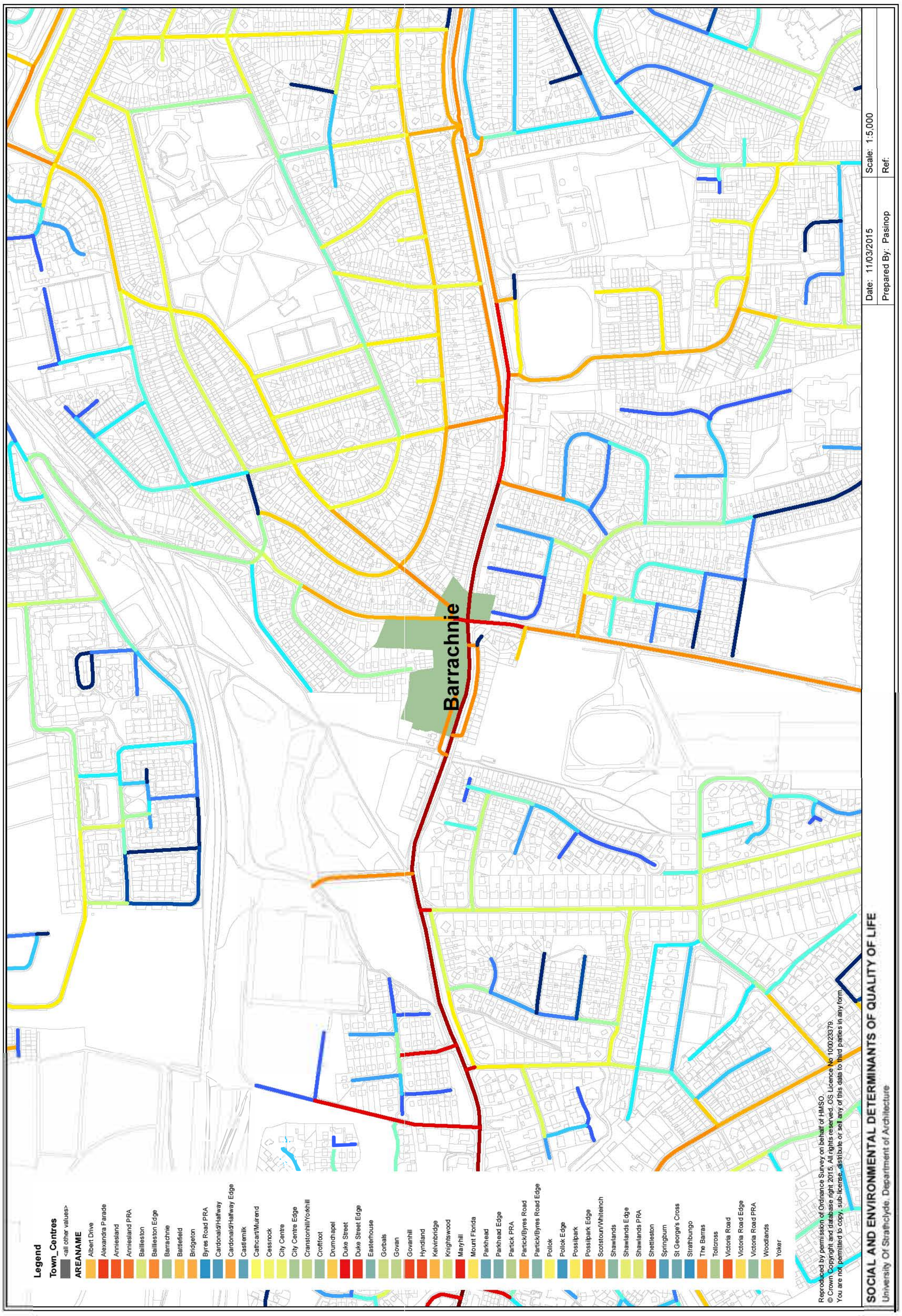


Figure 193. *Betweenness Centrality Index. Town Centre: Barrachnie.pdf*

8.2. Appendix 1: Town Centres and Betweenness index, exception

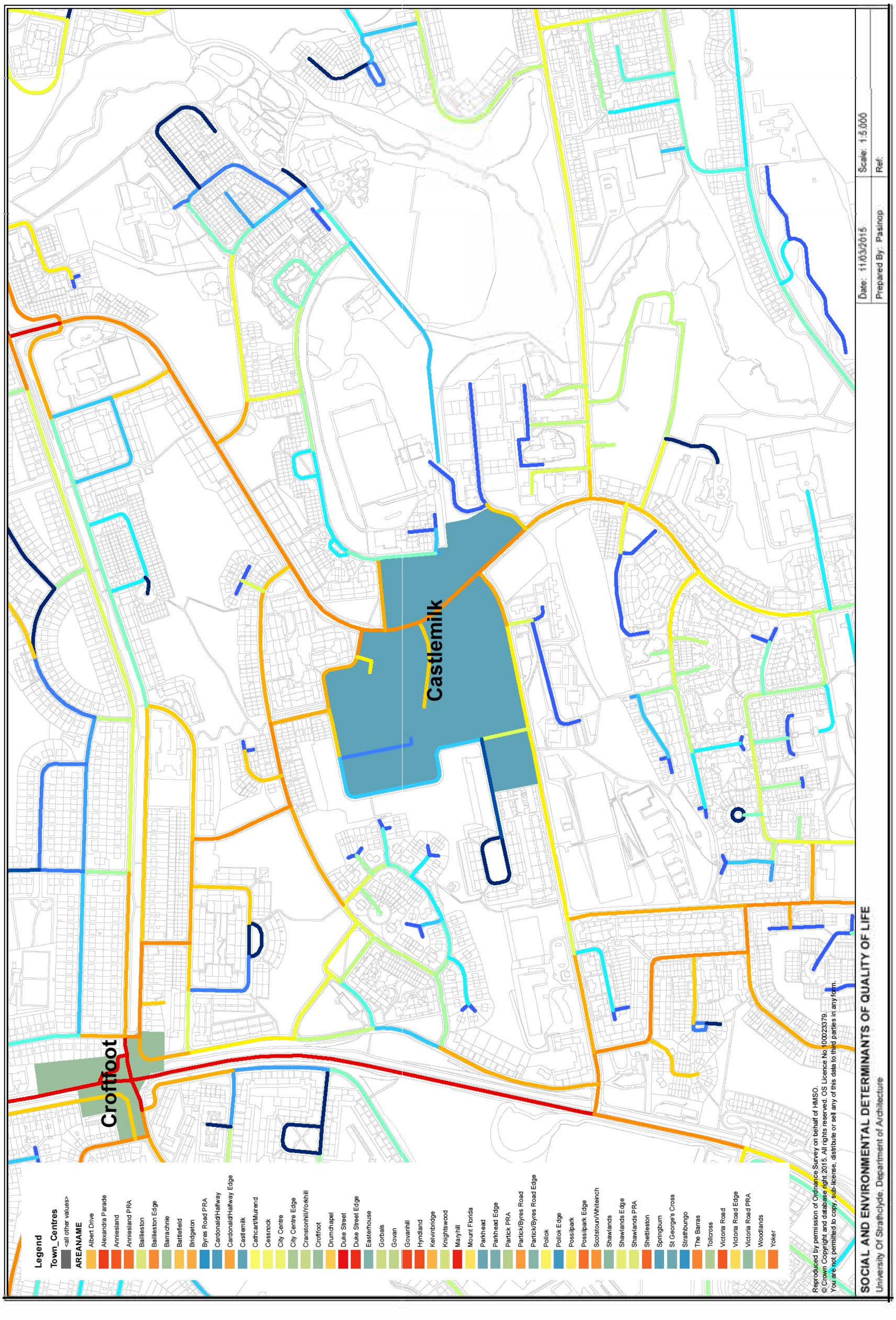


Figure 194. *Betweenness Centrality Index. Town Centre: Castlemilk.pdf*

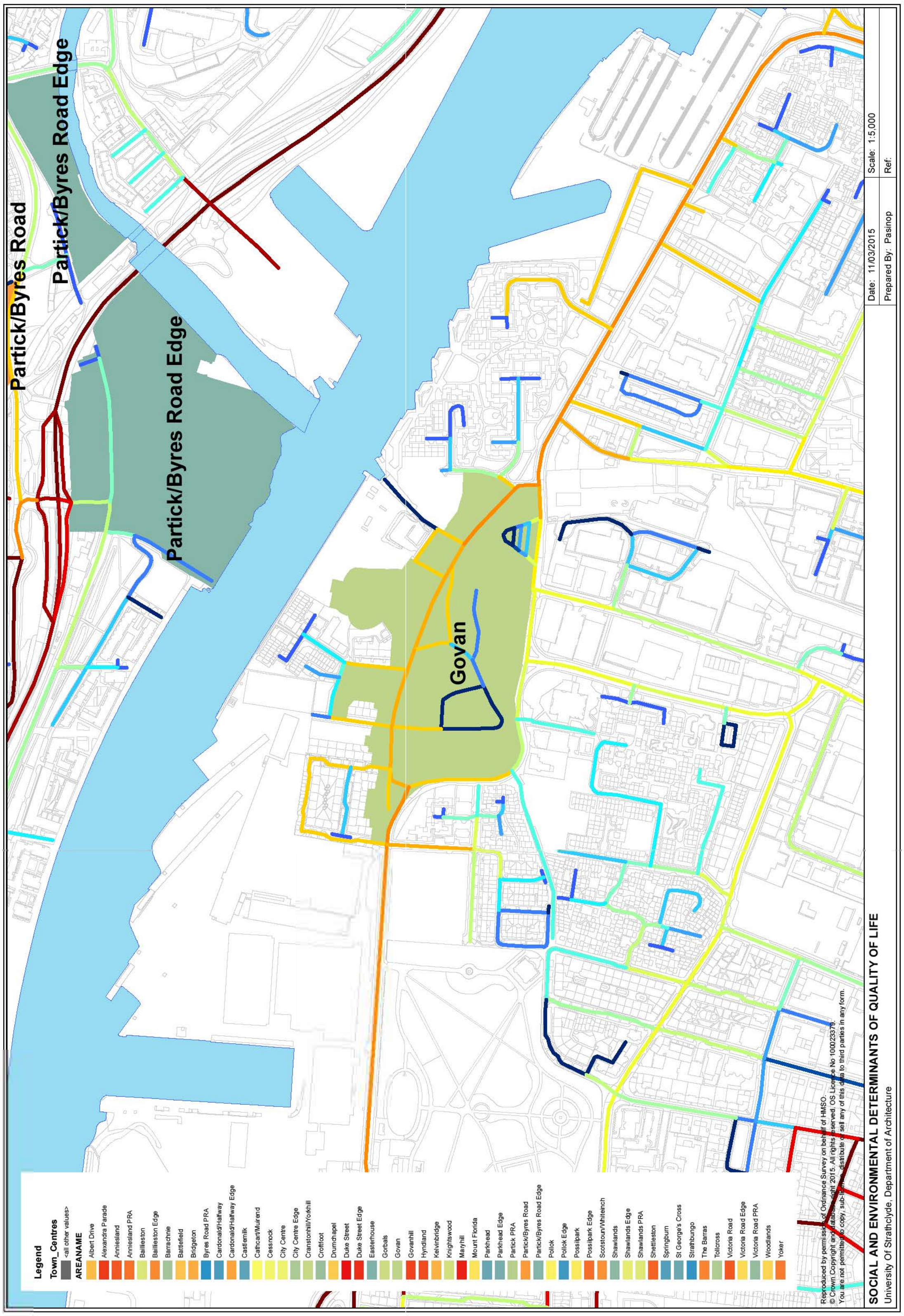


Figure 195. *Betweenness Centrality Index. Town Centre: Govan.pdf*

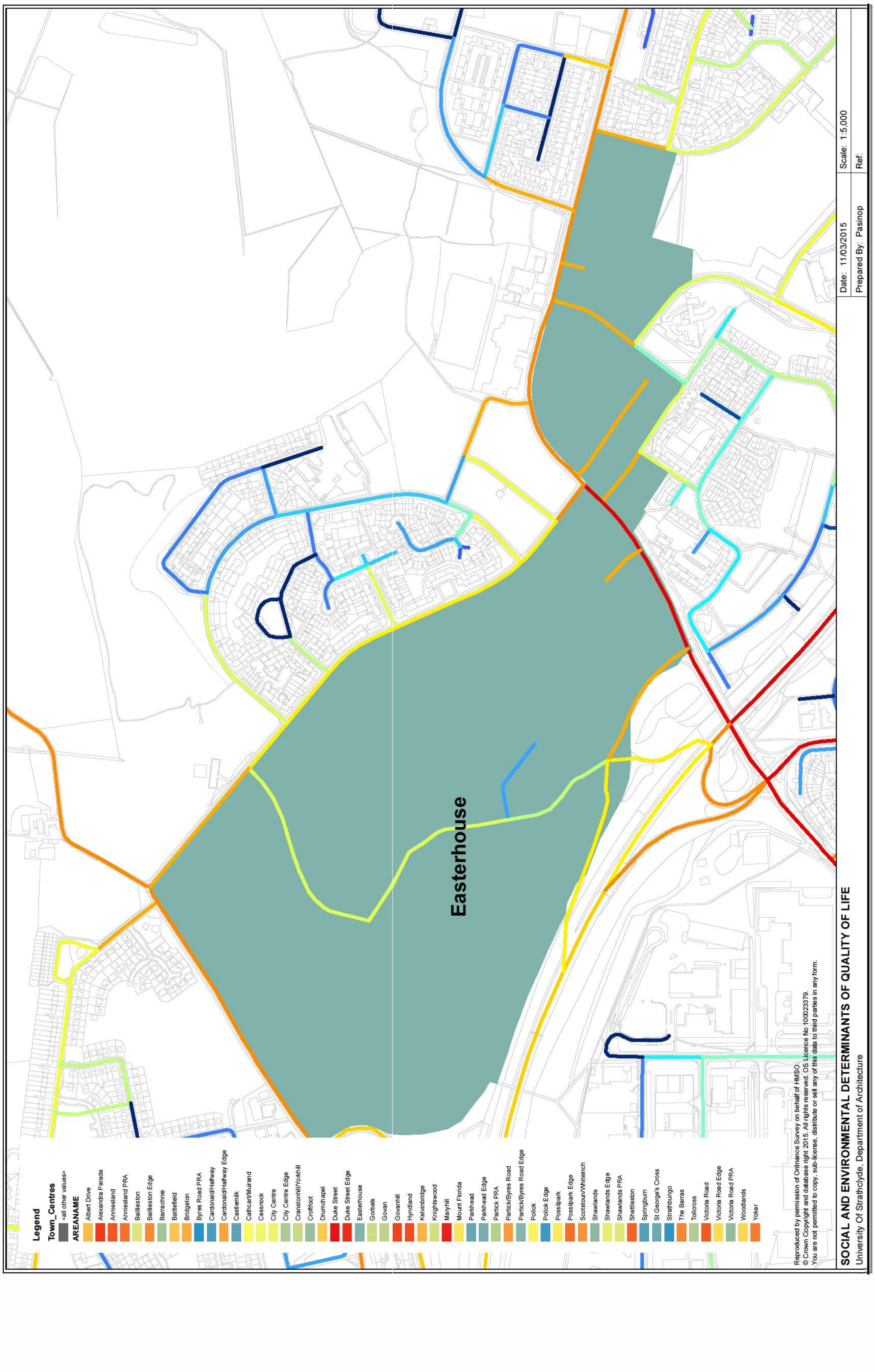


Figure 196. *Betweenness Centrality Index. Town Centre: Easterhouse.pdf*

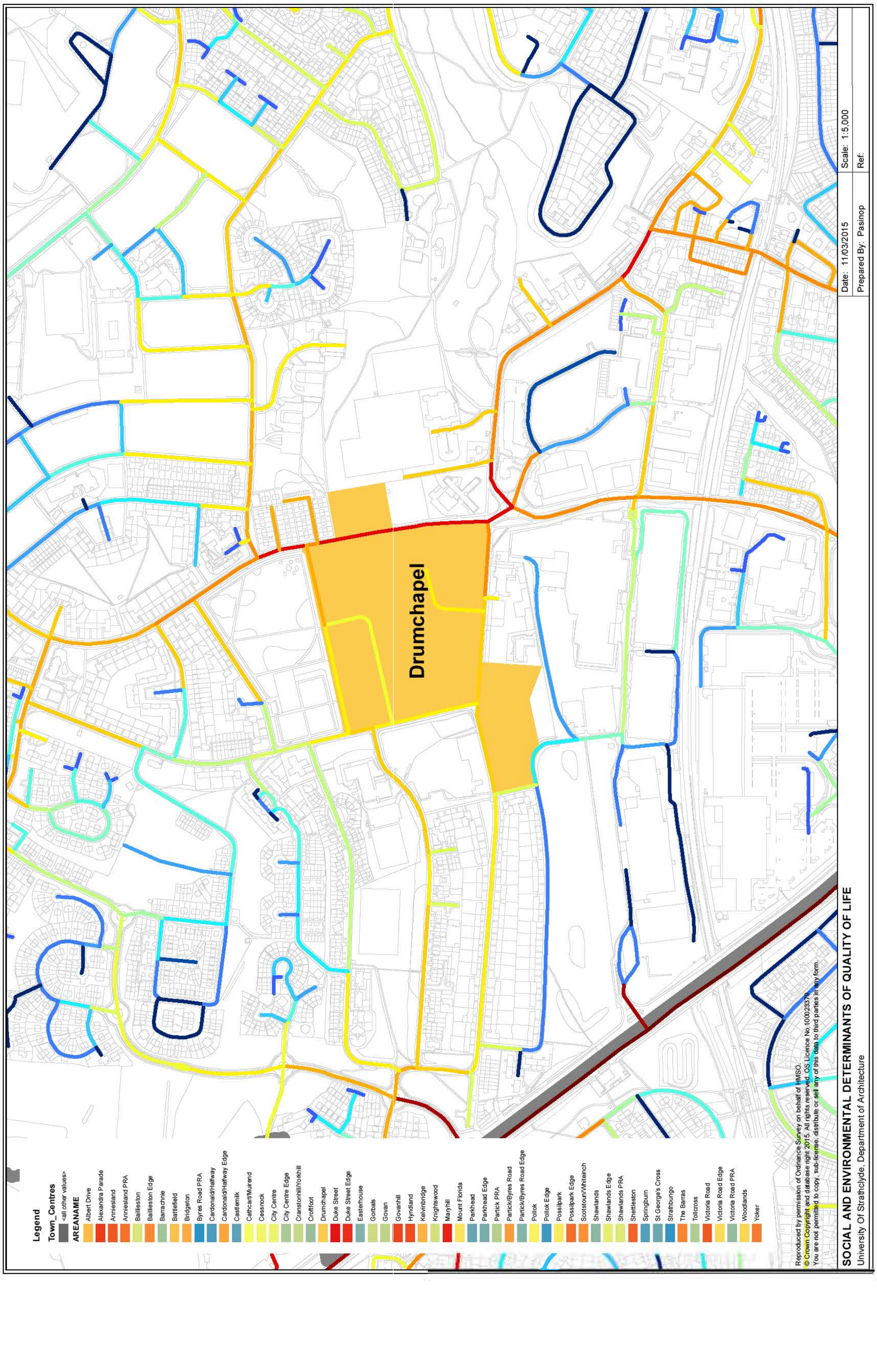


Figure 197. Betweenness Centrality Index. Town Centre: Drumchapel.pdf

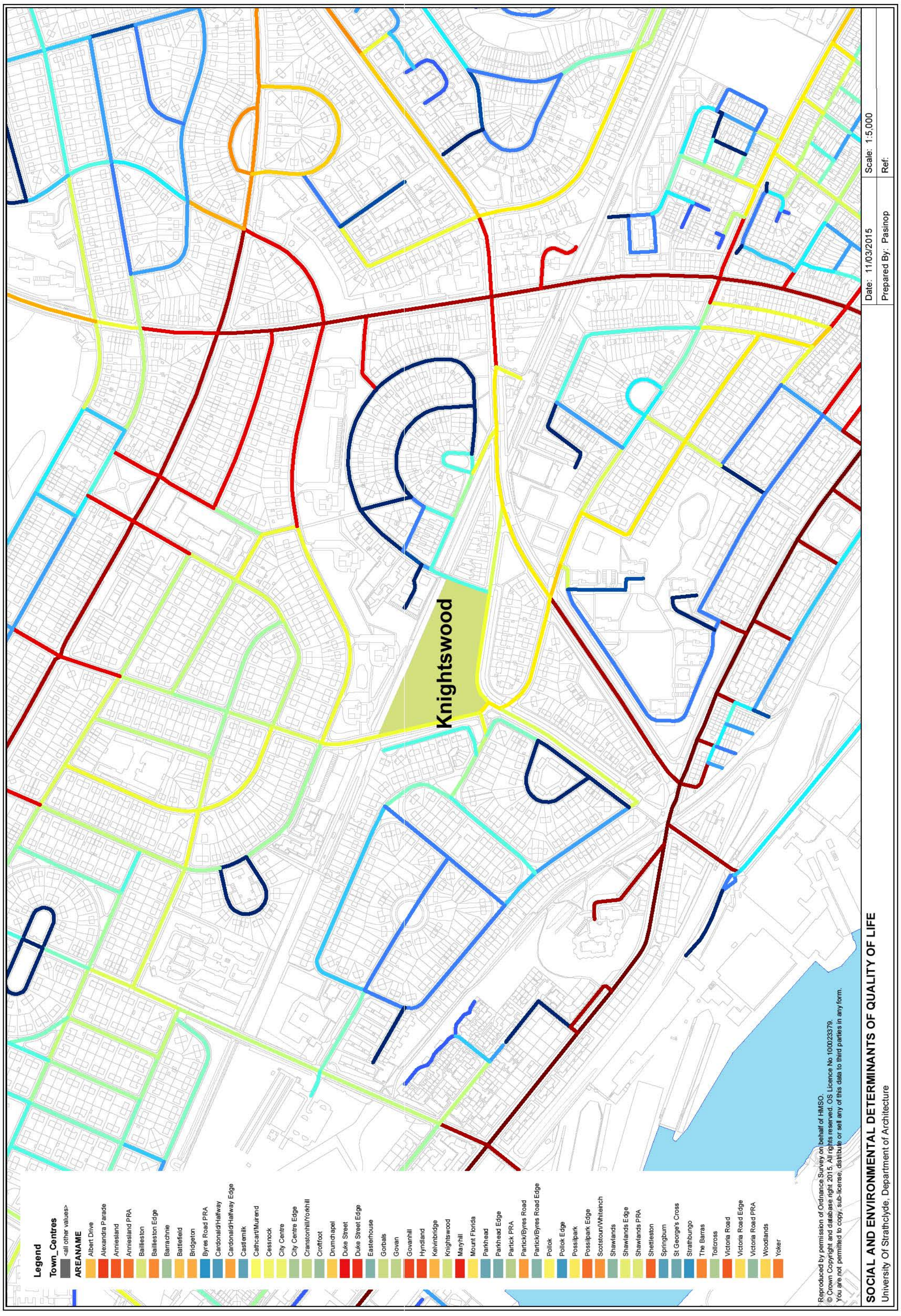


Figure 198. Betweenness Centrality Index. Town Centre: Knightswood.pdf

8.3. Appendix 2: Town Centres and Closeness @ 400m index

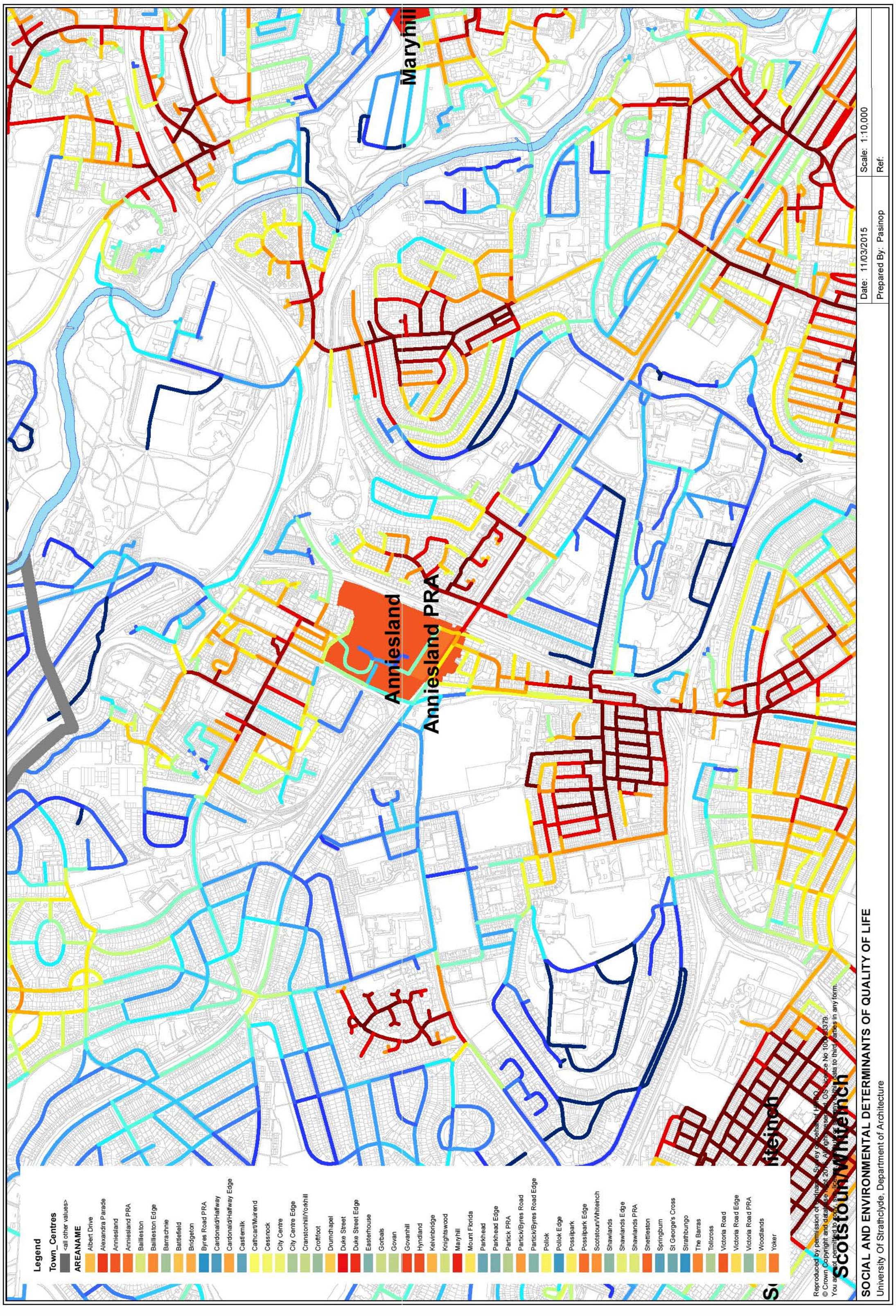


Figure 199. Closeness @400 Centrality Index. Town Centre: Anniesland PRA.pdf

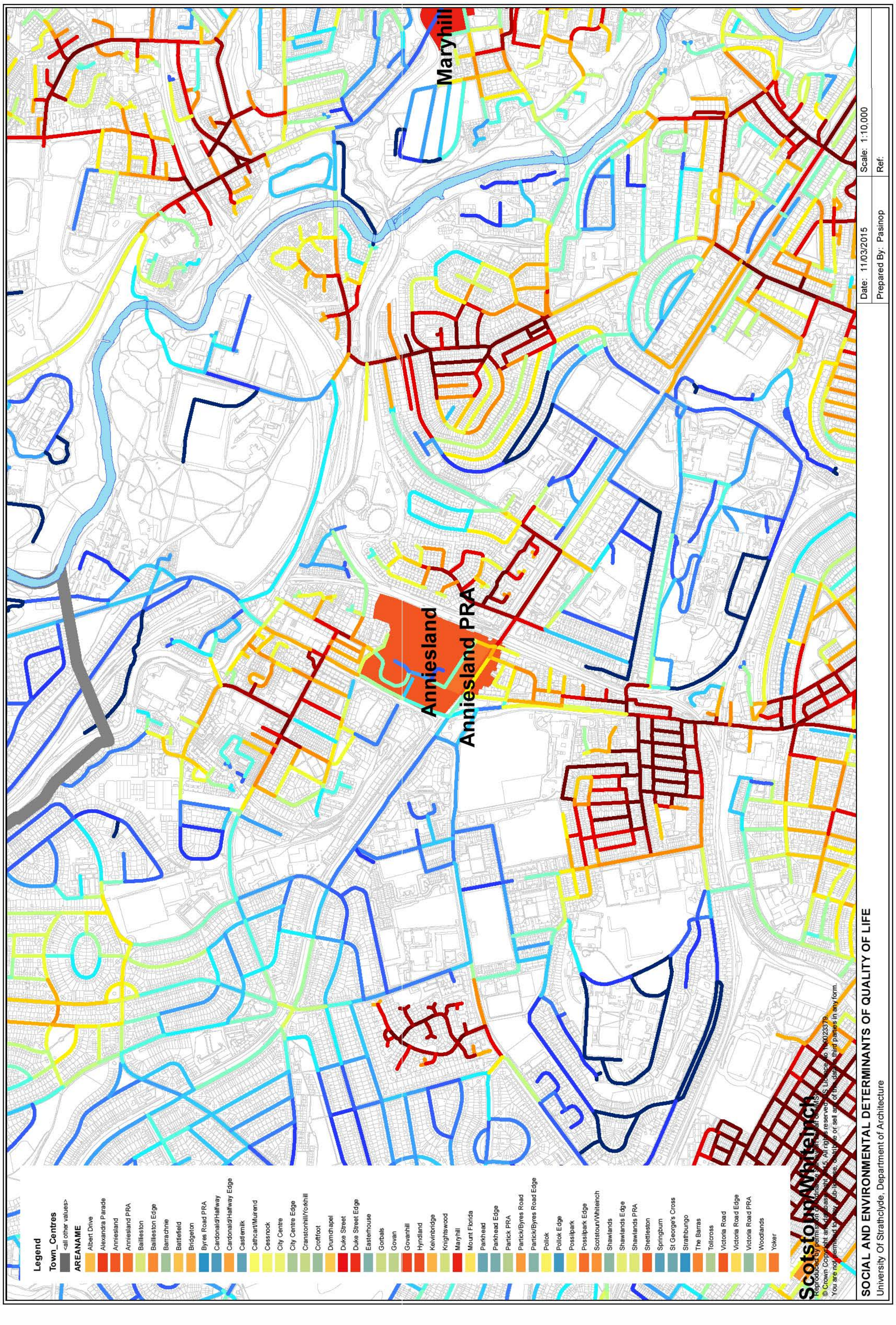


Figure 200. *Closeness @400 Centrality Index. Town Centre: Anniesland.pdf*

Figure 201. Closeness @400 Centrality Index. Town Centre: Battlefield.pdf

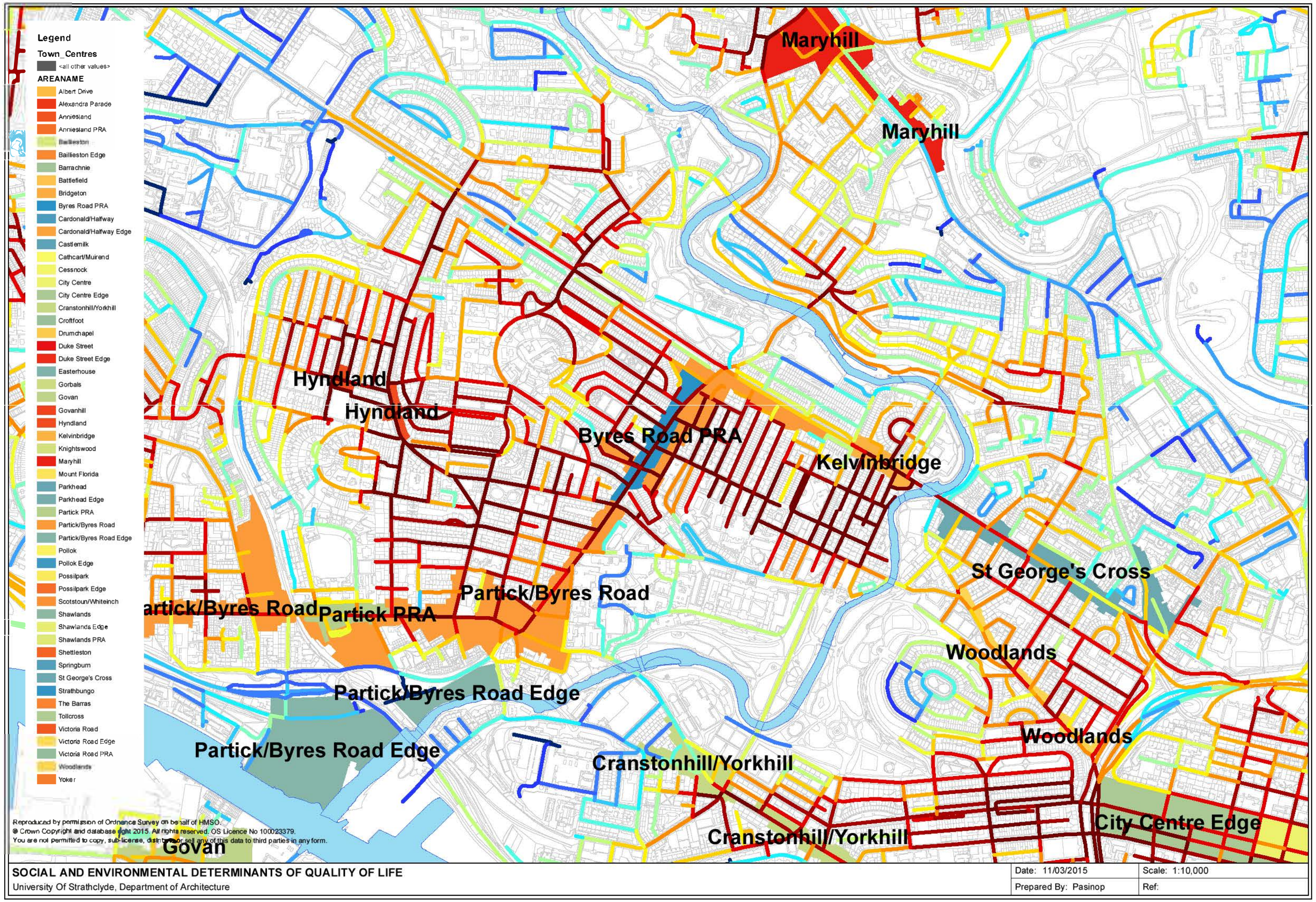


Figure 202. Closeness @400 Centrality Index. Town Centre: Byres Road PRA.pdf

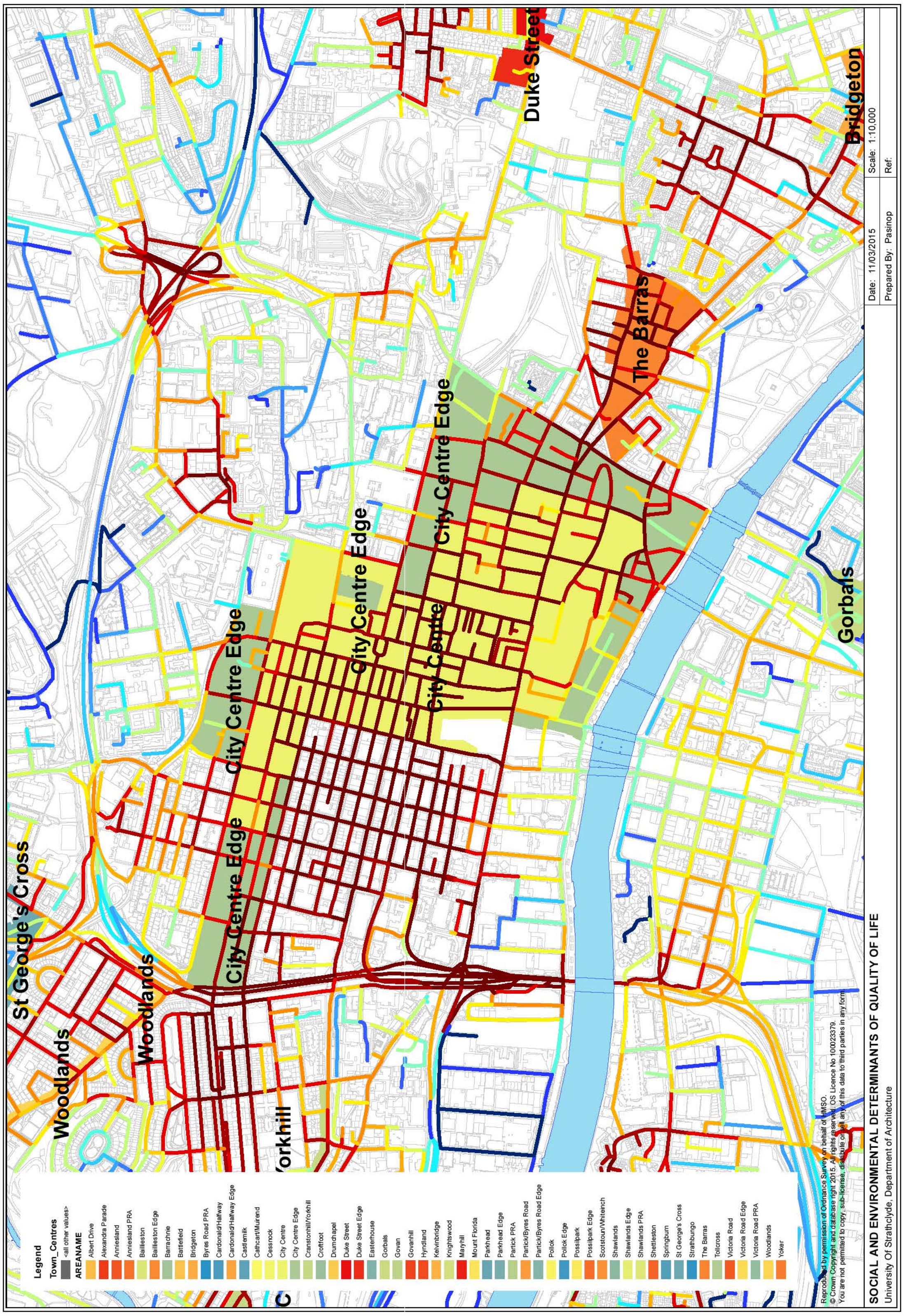


Figure 203. *Closeness @400 Centrality Index. Town Centre: City Centre.pdf*

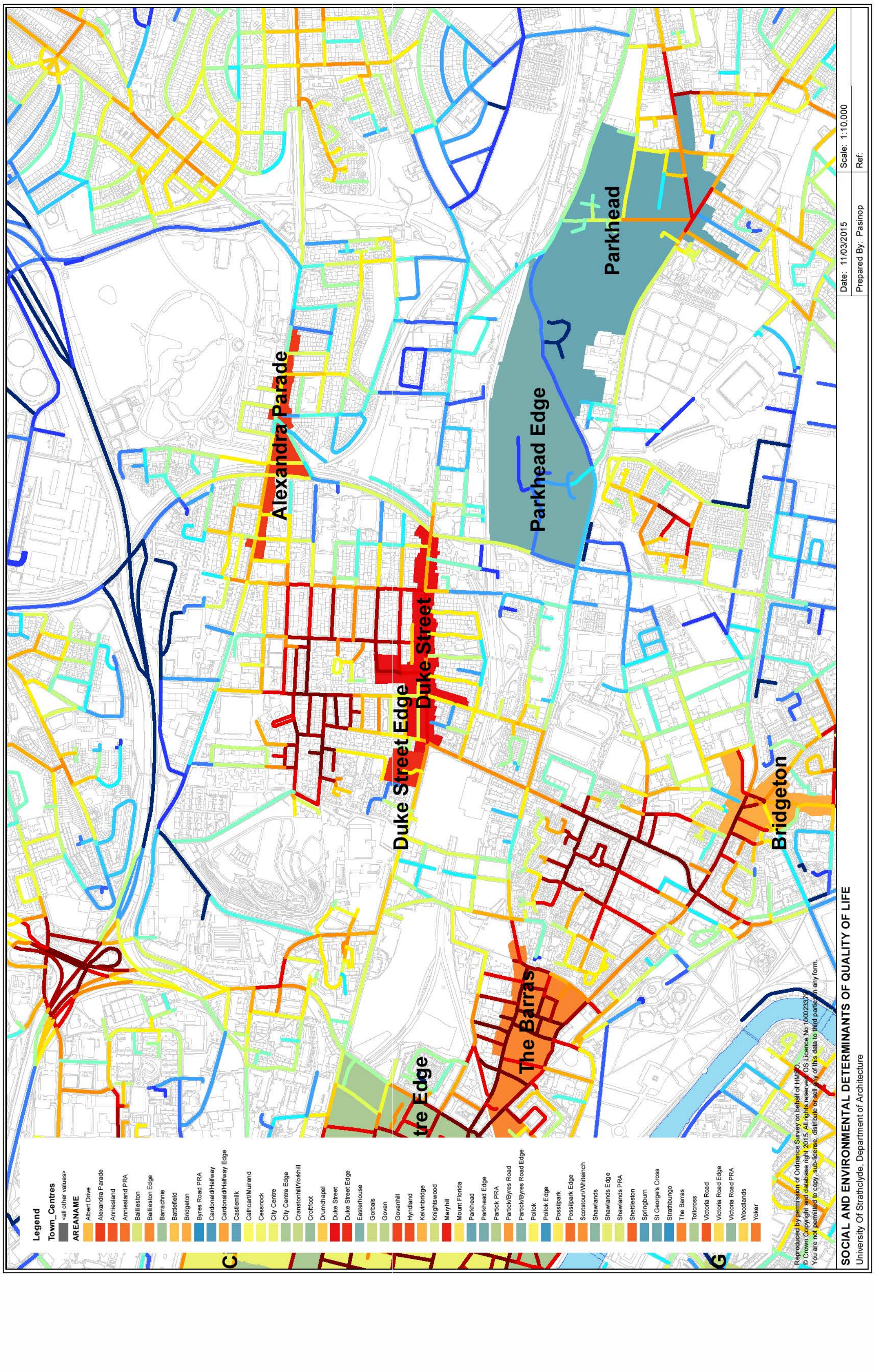


Figure 204. Closeness @400 Centrality Index. Town Centre: Duke Street.pdf

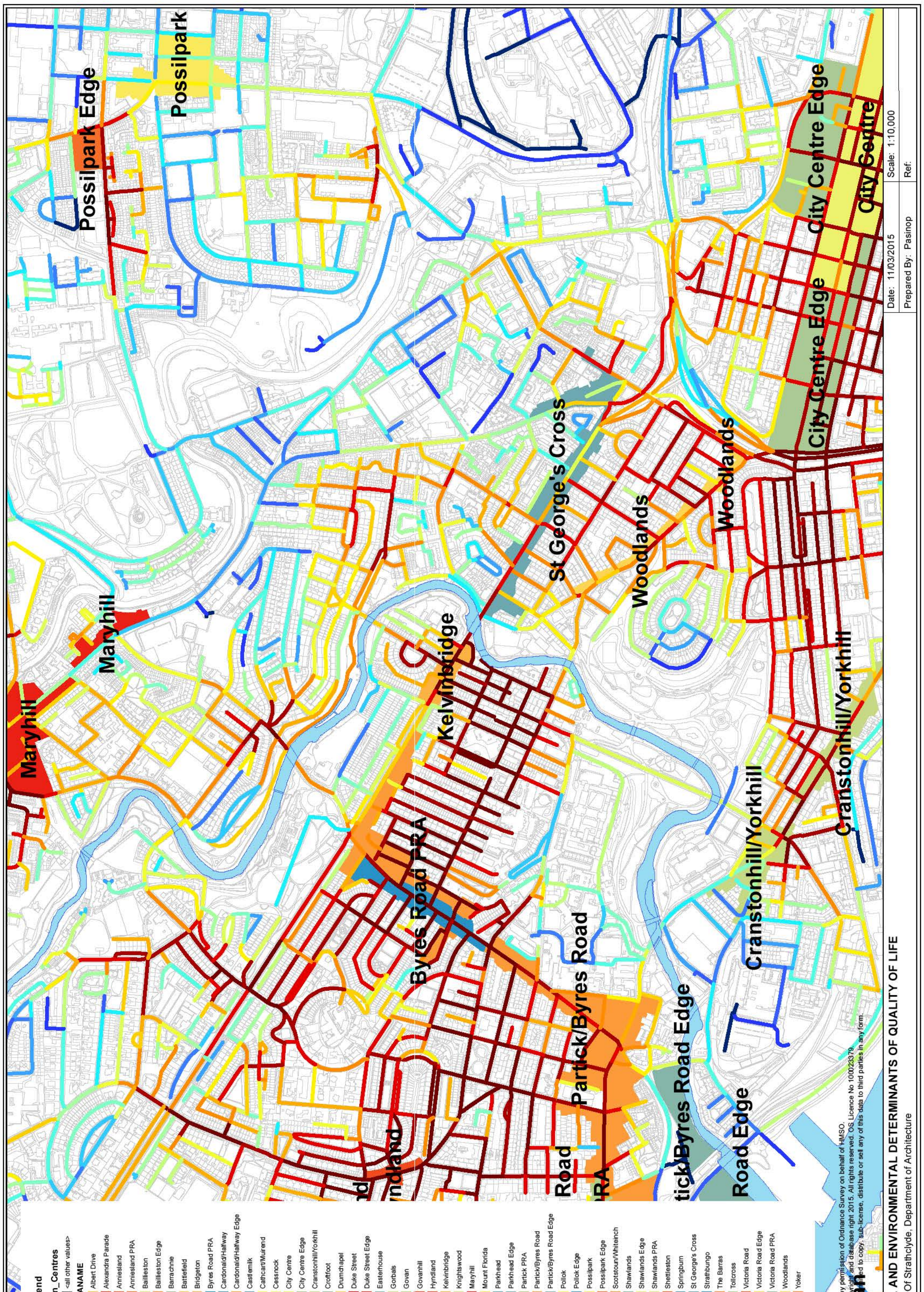


Figure 205. *Closeness @400 Centrality Index. Town Centre: Kelvinbridge.pdf*

Figure 206. *Closeness @400 Centrality Index. Town Centre: Mount Florida.pdf*

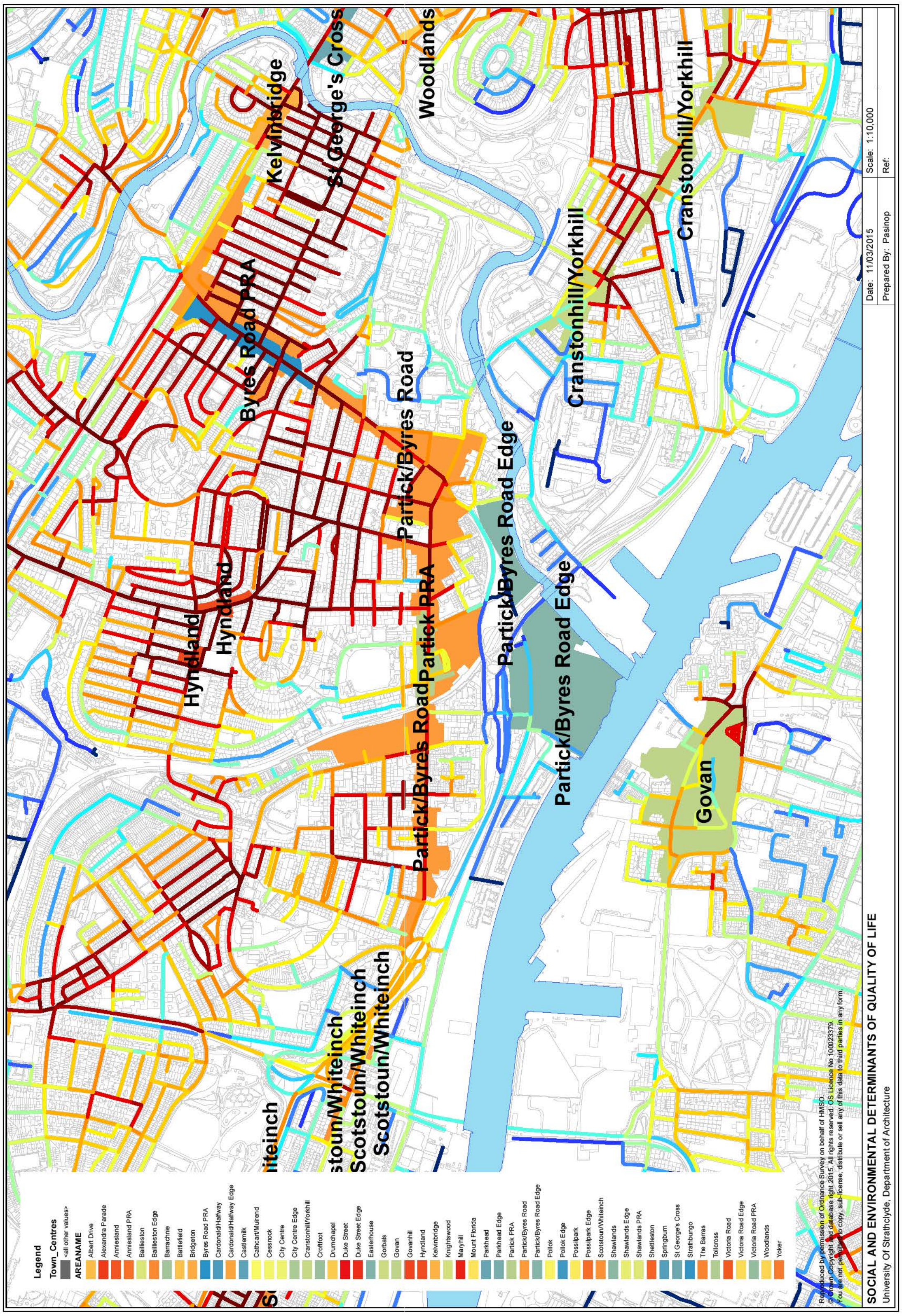


Figure 207. Closeness @400 Centrality Index. Town Centre: Partick PRA.pdf

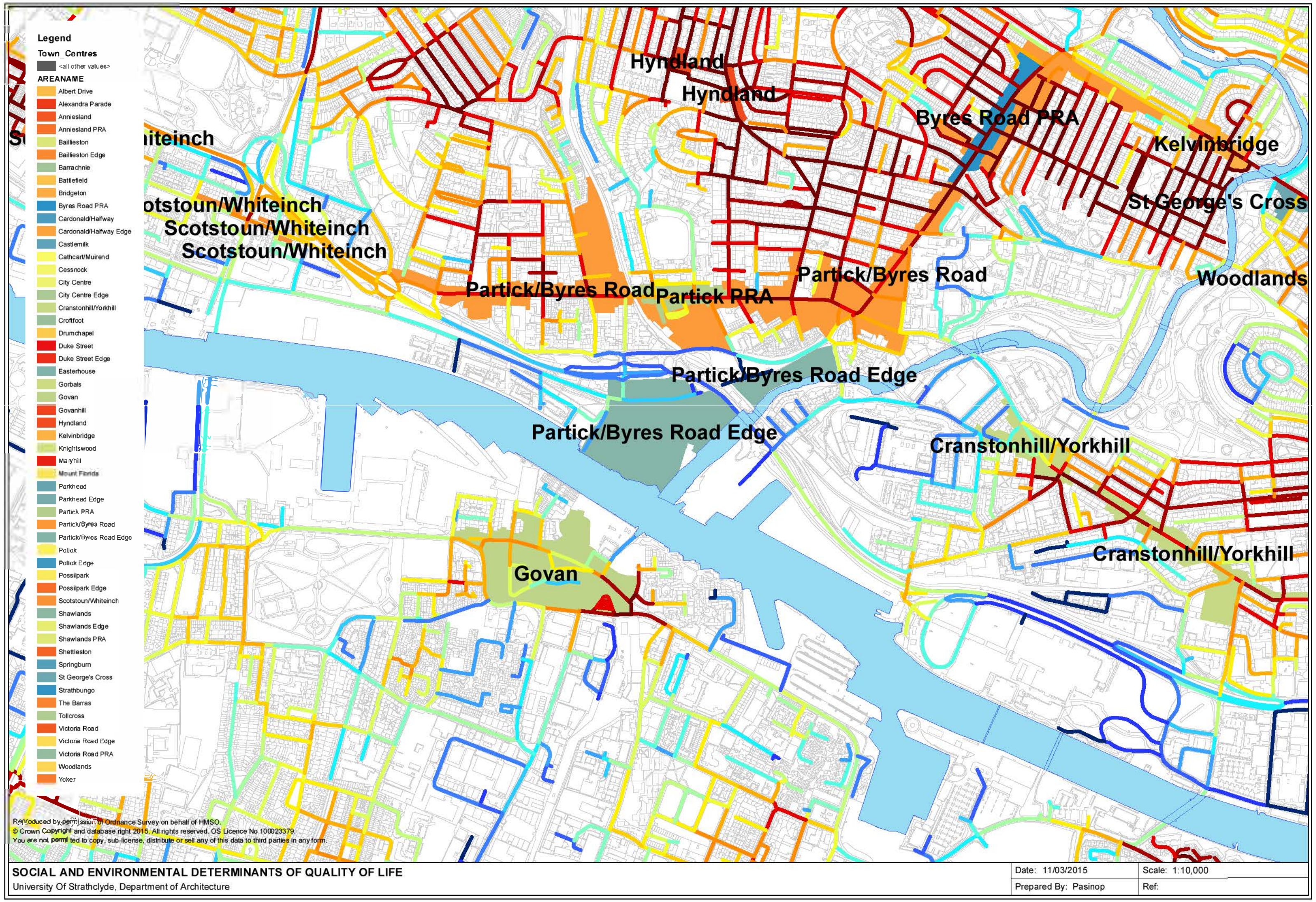


Figure 208. Closeness @400 Centrality Index: Town Centre: Partick_Byres Road Edge.pdf

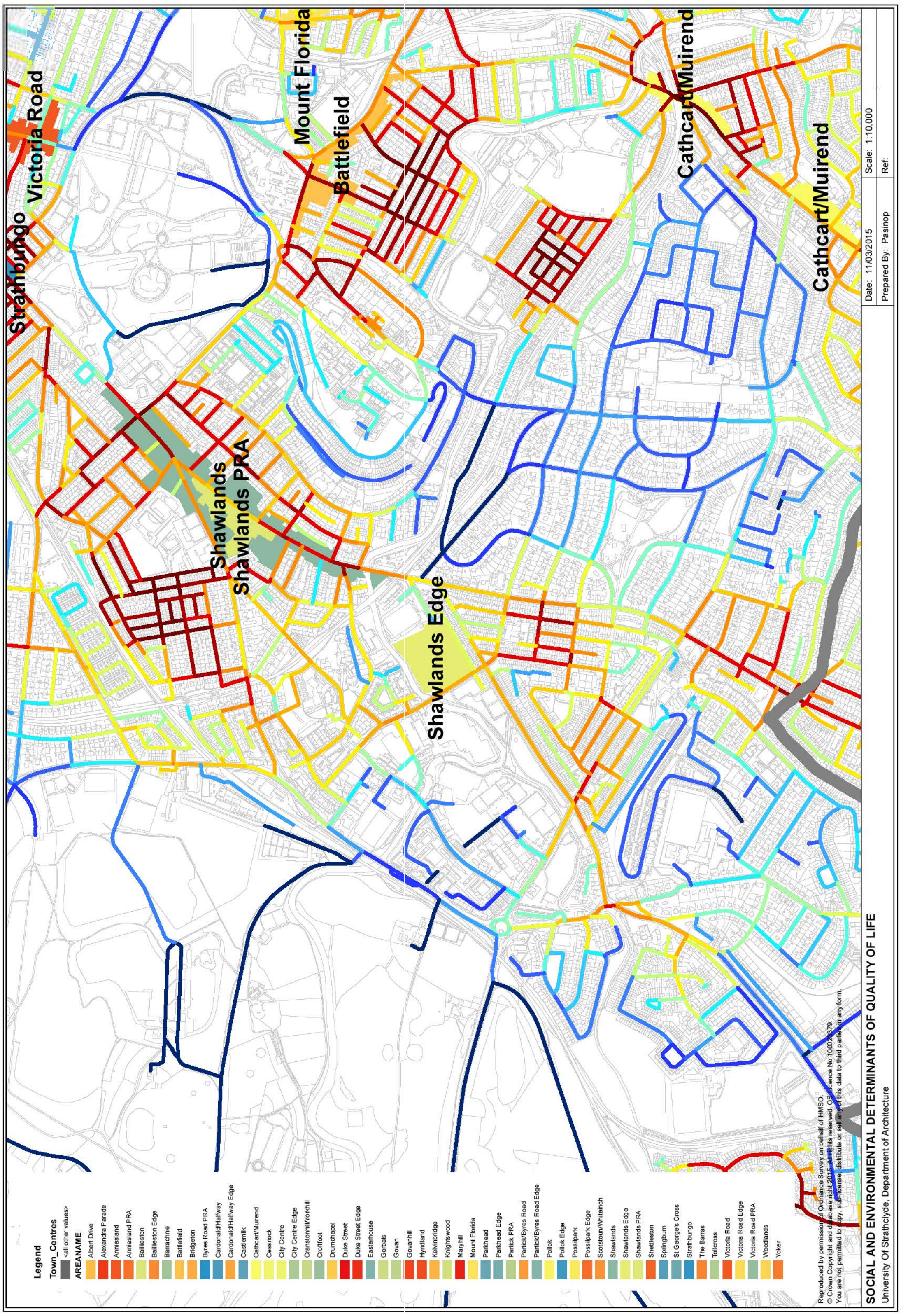


Figure 209. Closeness @400 Centrality Index. Town Centre: Shawlands Edge.pdf

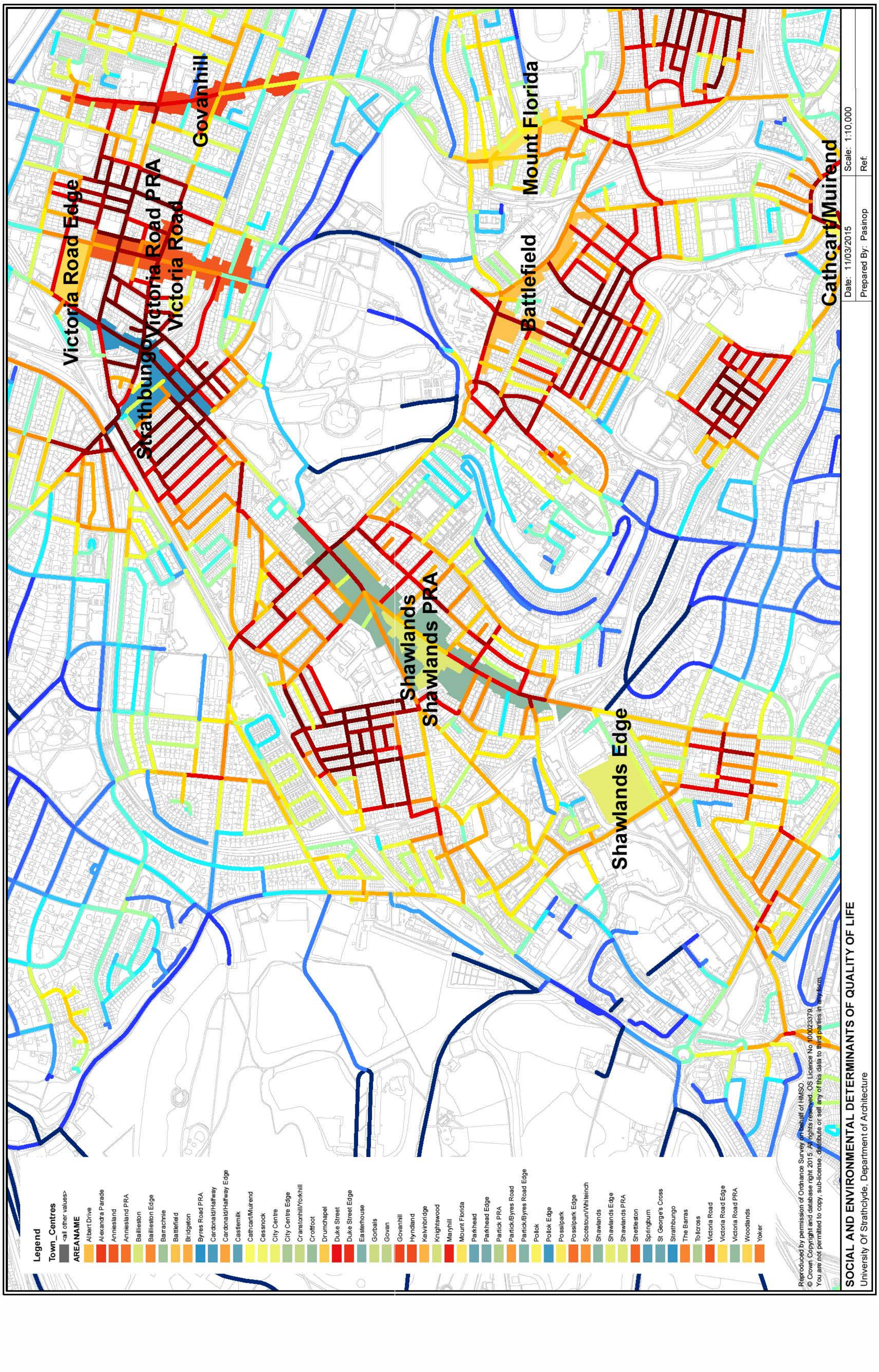


Figure 210. Closeness @400 Centrality Index. Town Centre: Shawlands PRA.pdf

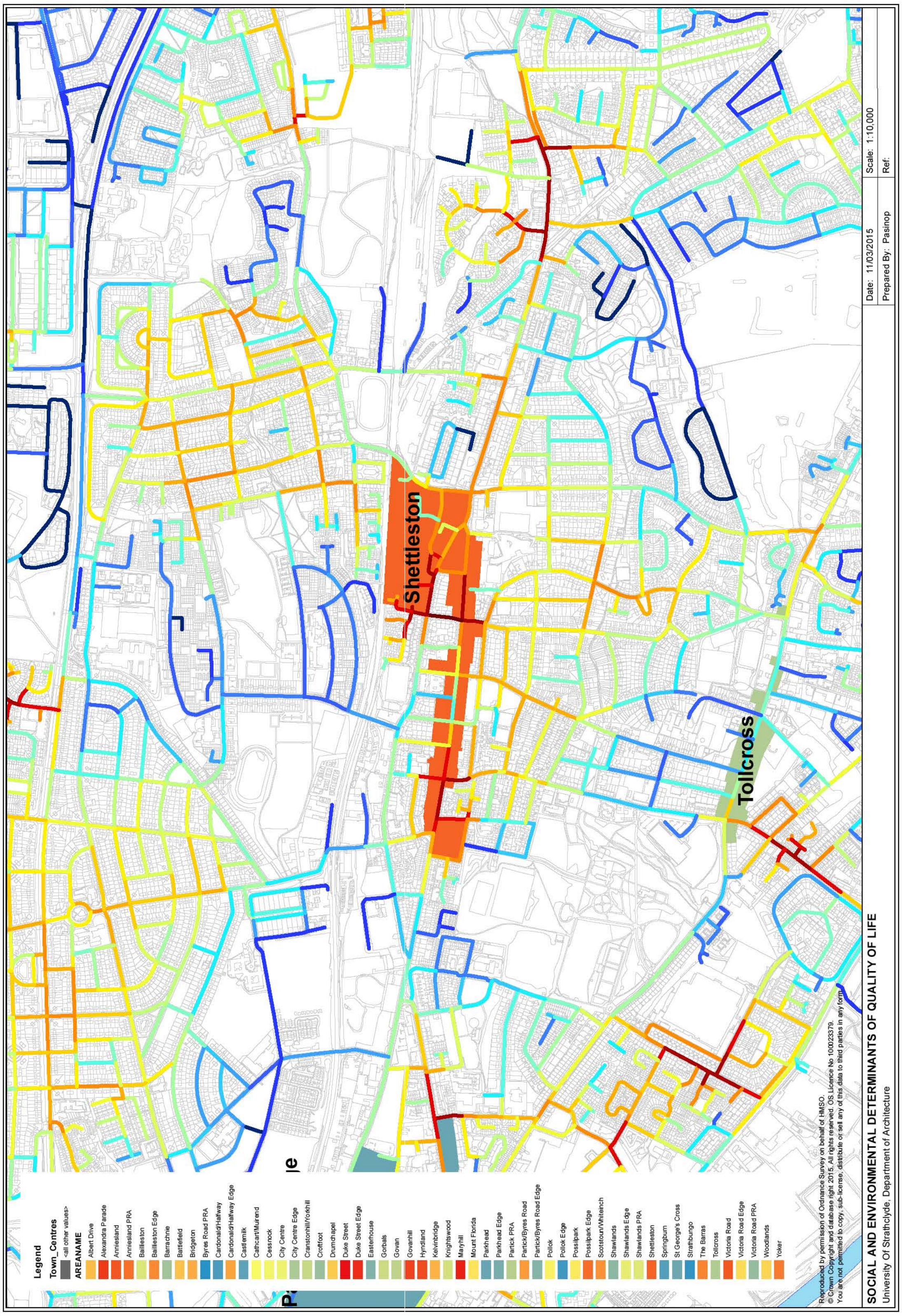


Figure 211. *Closeness @400 Centrality Index. Town Centre: Shettleston.pdf*

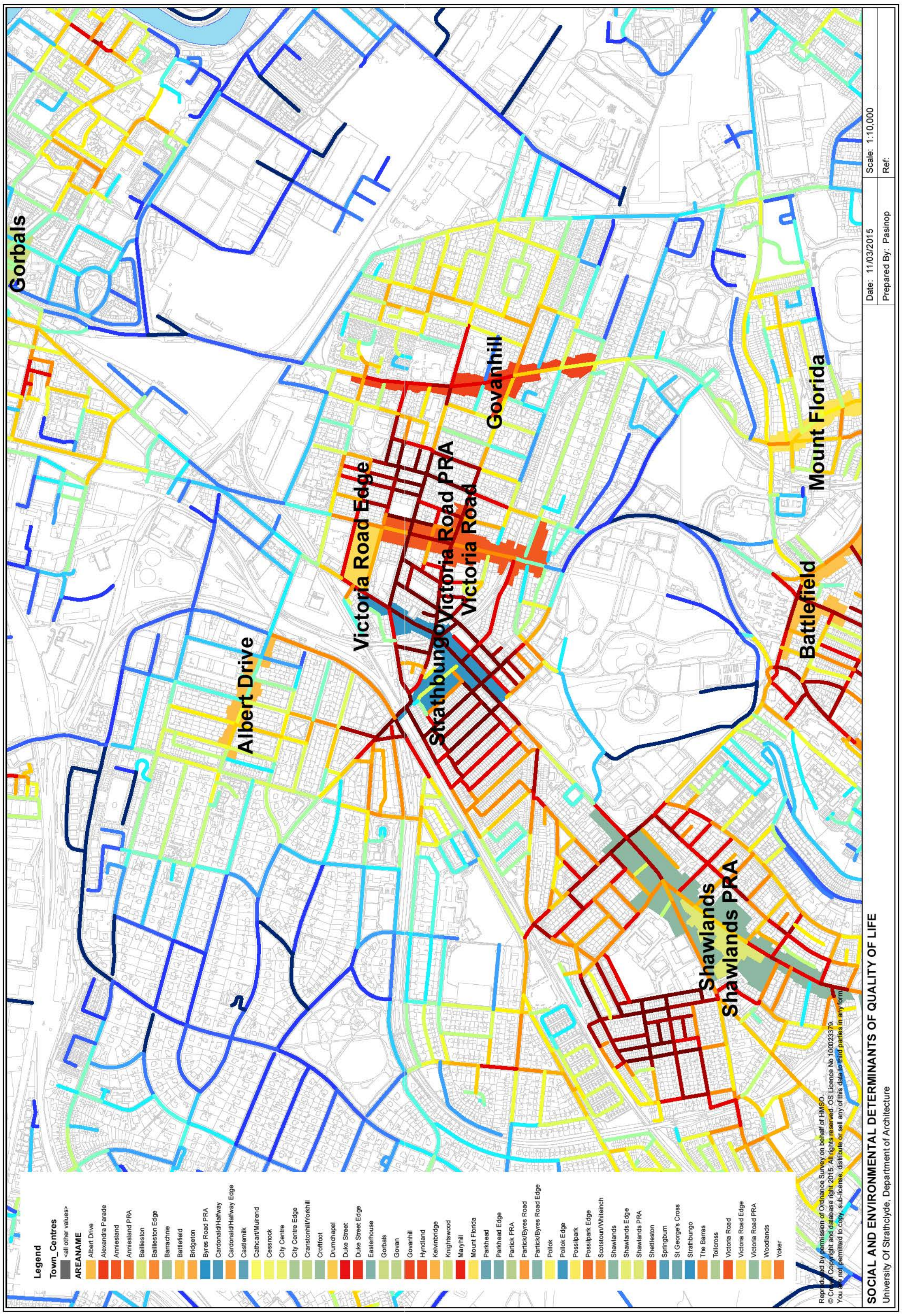


Figure 212. Closeness @400 Centrality Index. Town Centre: Strathbungo.pdf

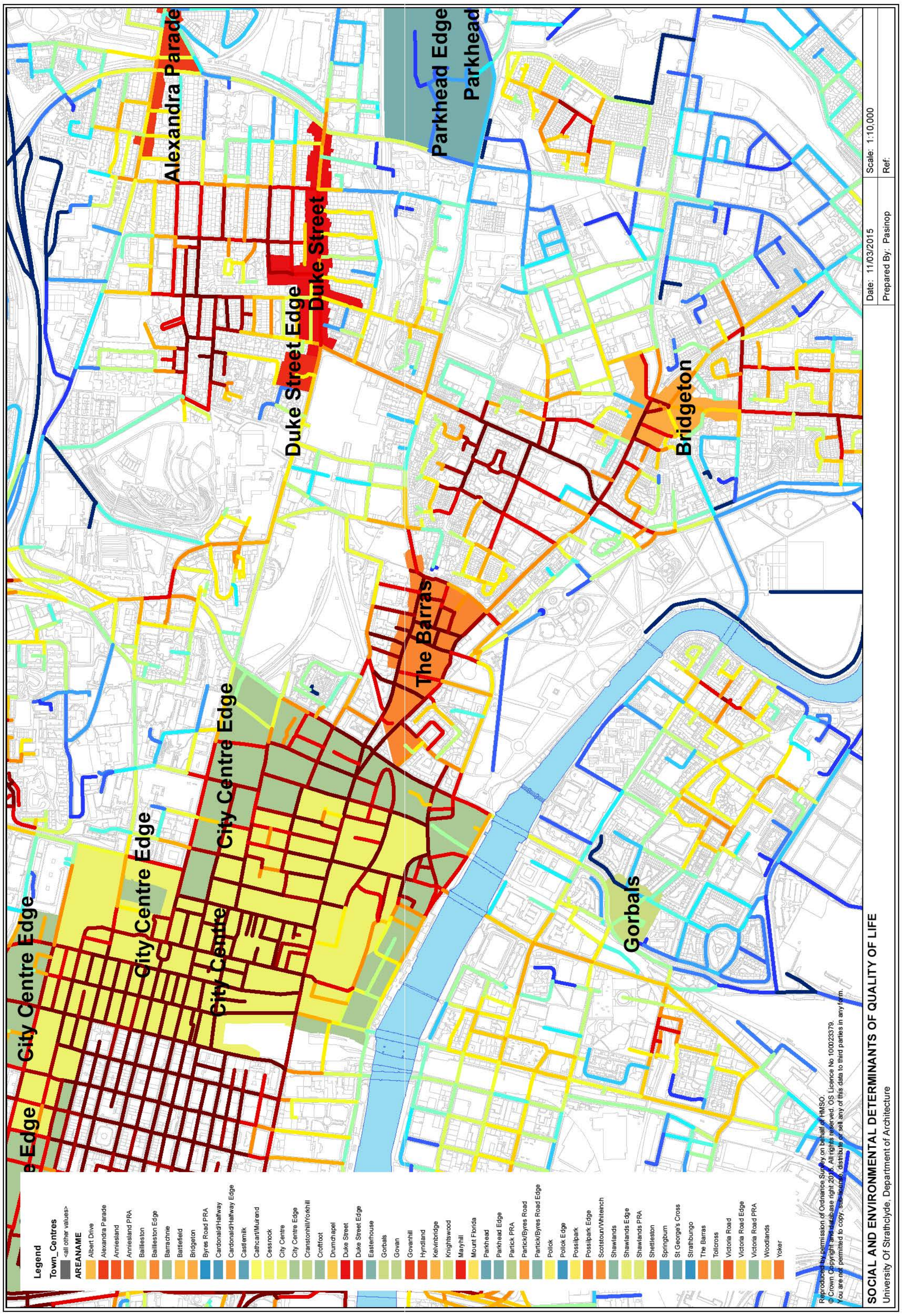


Figure 213. Closeness @400 Centrality Index. Town Centre: The Barras.pdf

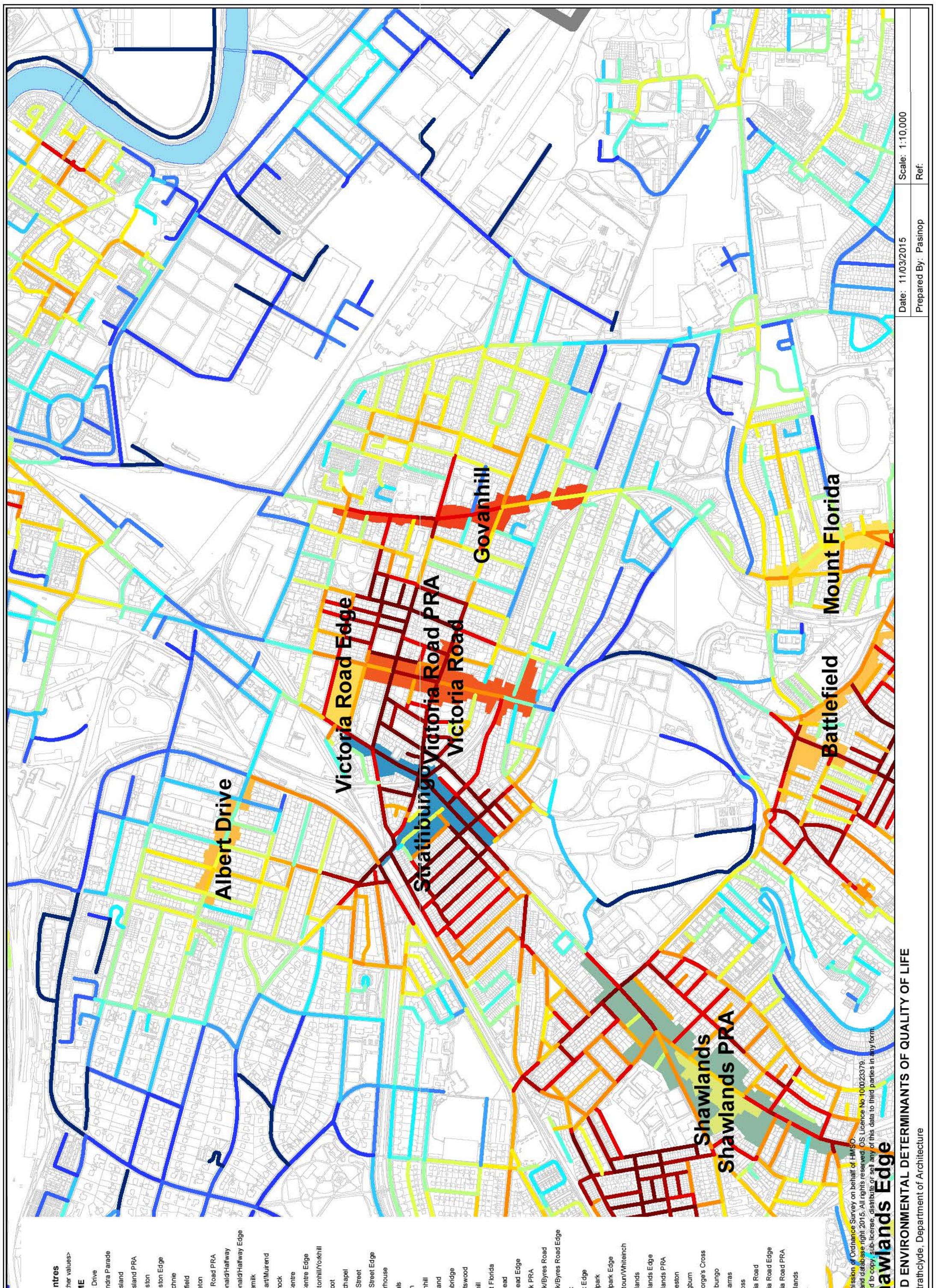


Figure 214. *Closeness @400 Centrality Index. Town Centre: Victoria Road.pdf*

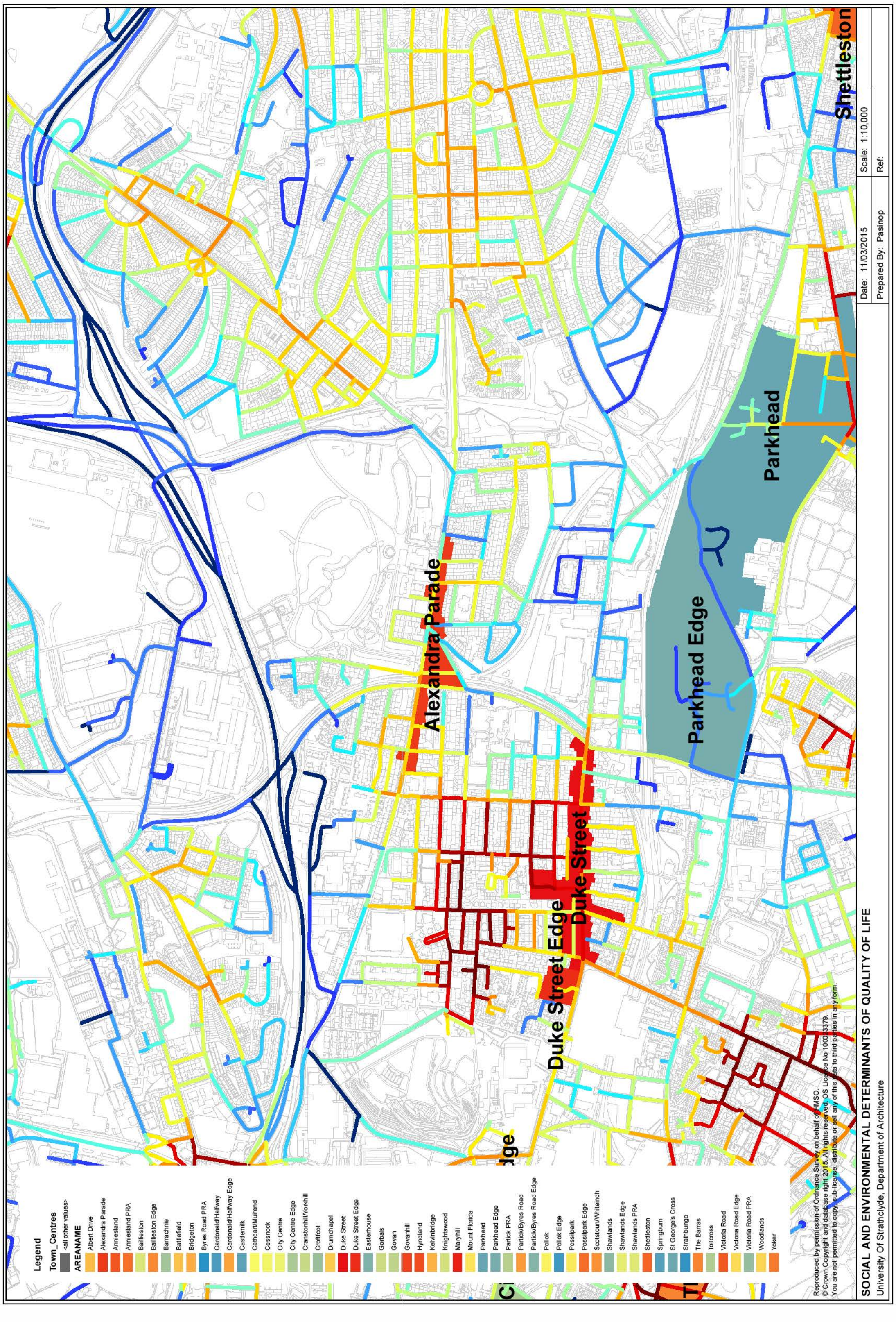


Figure 215. Closeness @400 Centrality Index. Town Centre: Alexandra Parade.pdf

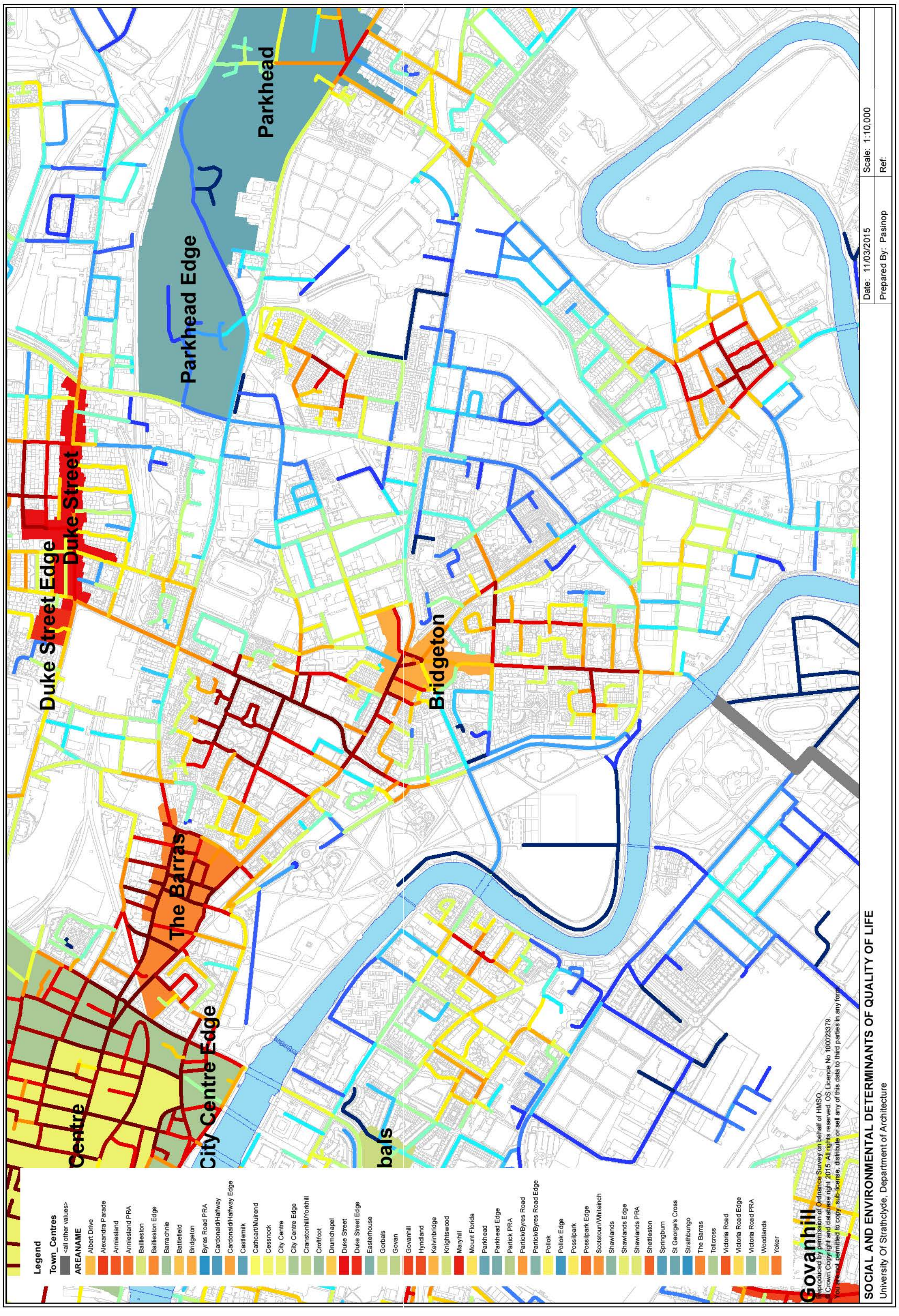


Figure 216. *Closeness @400 Centrality Index. Town Centre: Bridgeton.pdf*

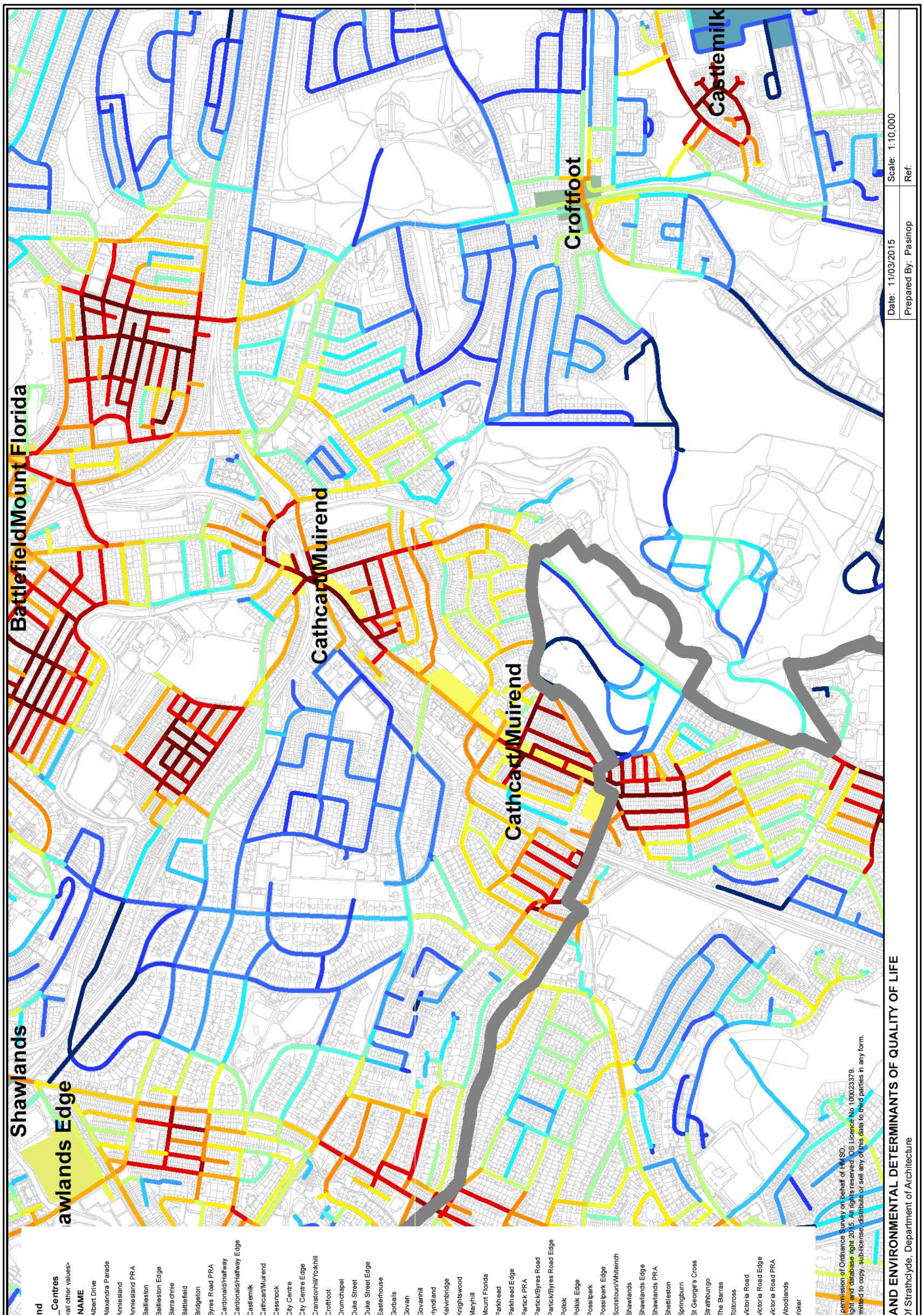


Figure 217. Closeness @400 Centrality Index. Town Centre: Cathcart_Muirend.pdf

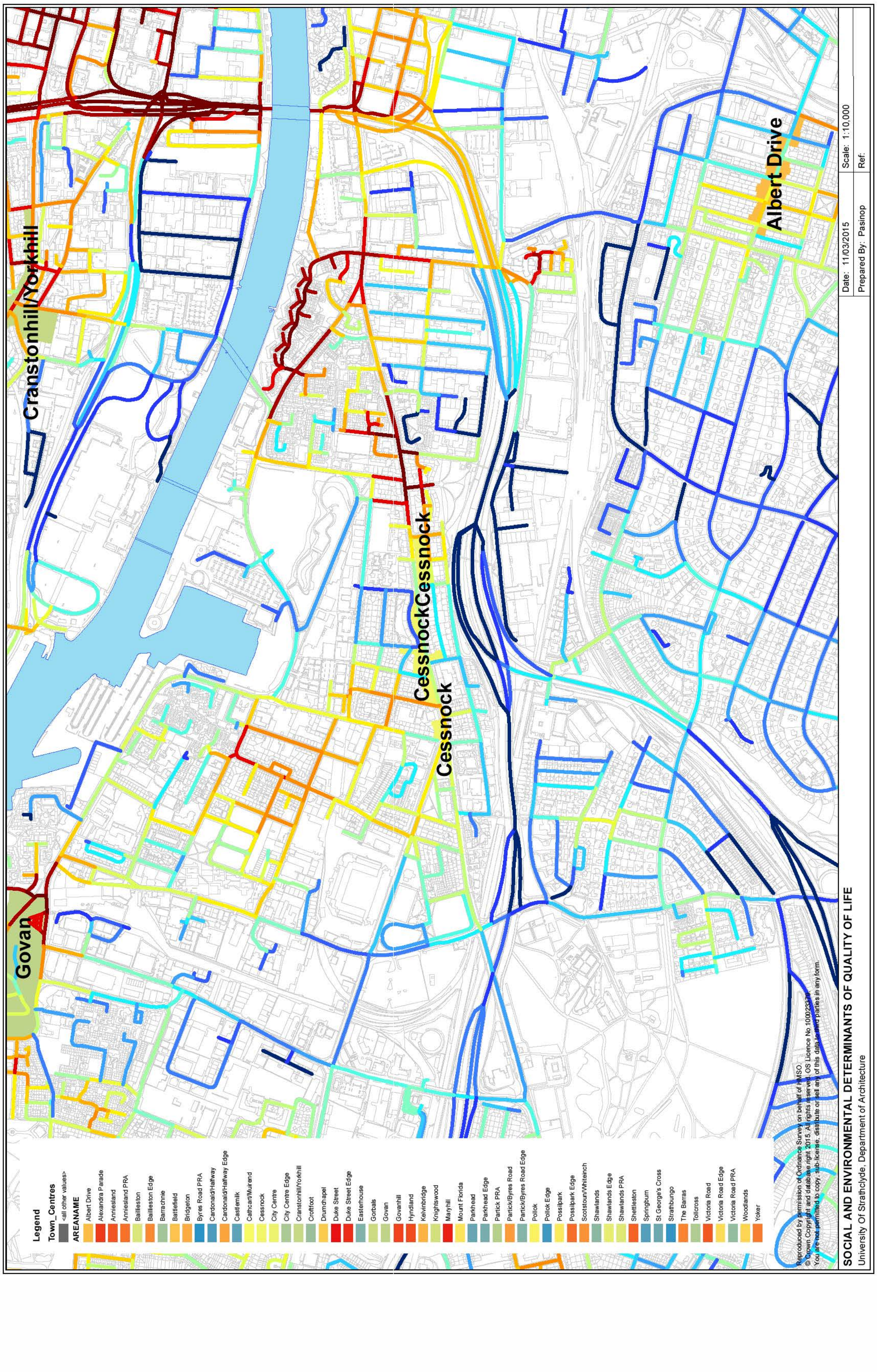


Figure 218. Closeness @400 Centrality Index. Town Centre: Cessnock.pdf

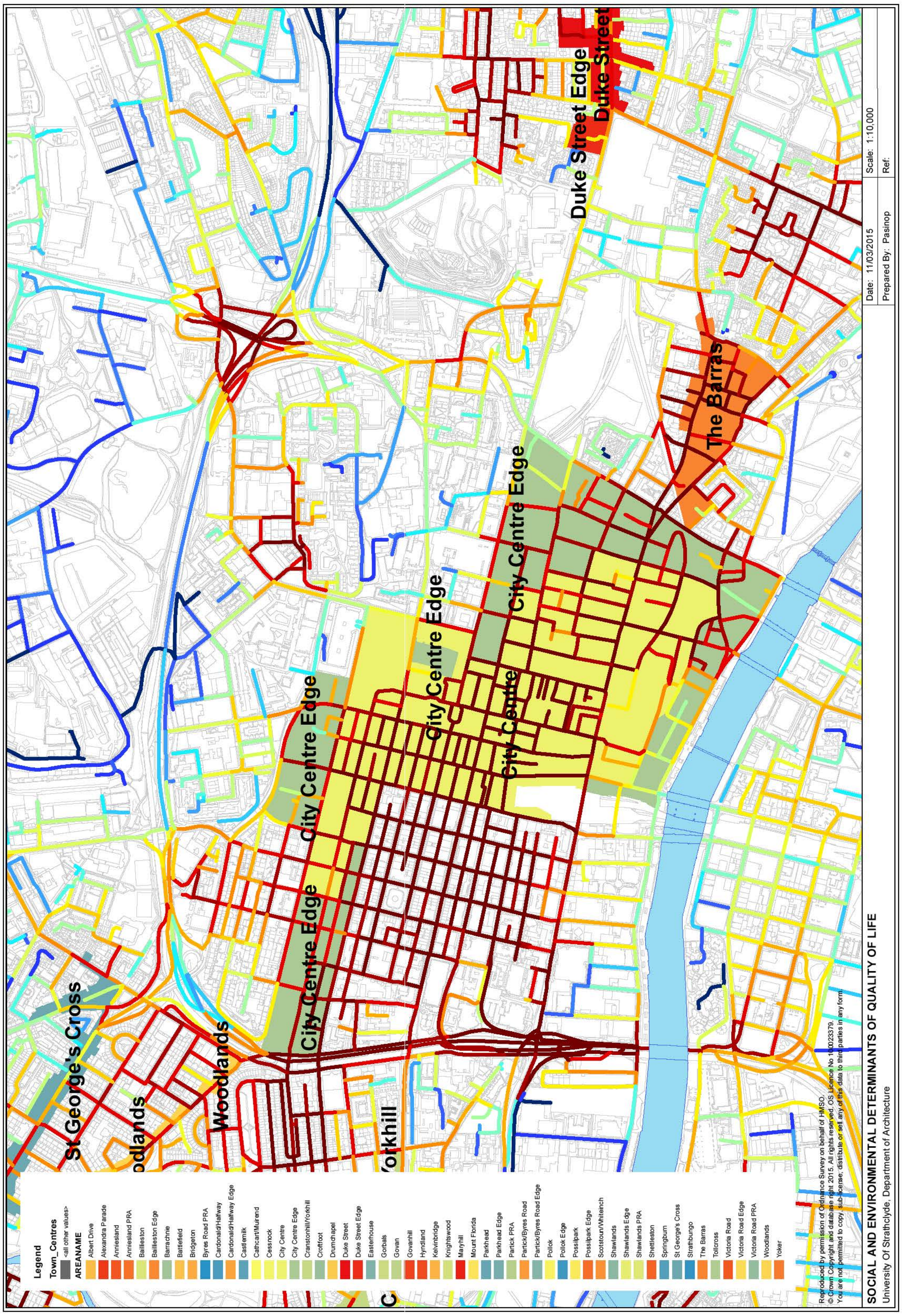


Figure 219. Closeness @400 Centrality Index. Town Centre: City Centre Edge.pdf

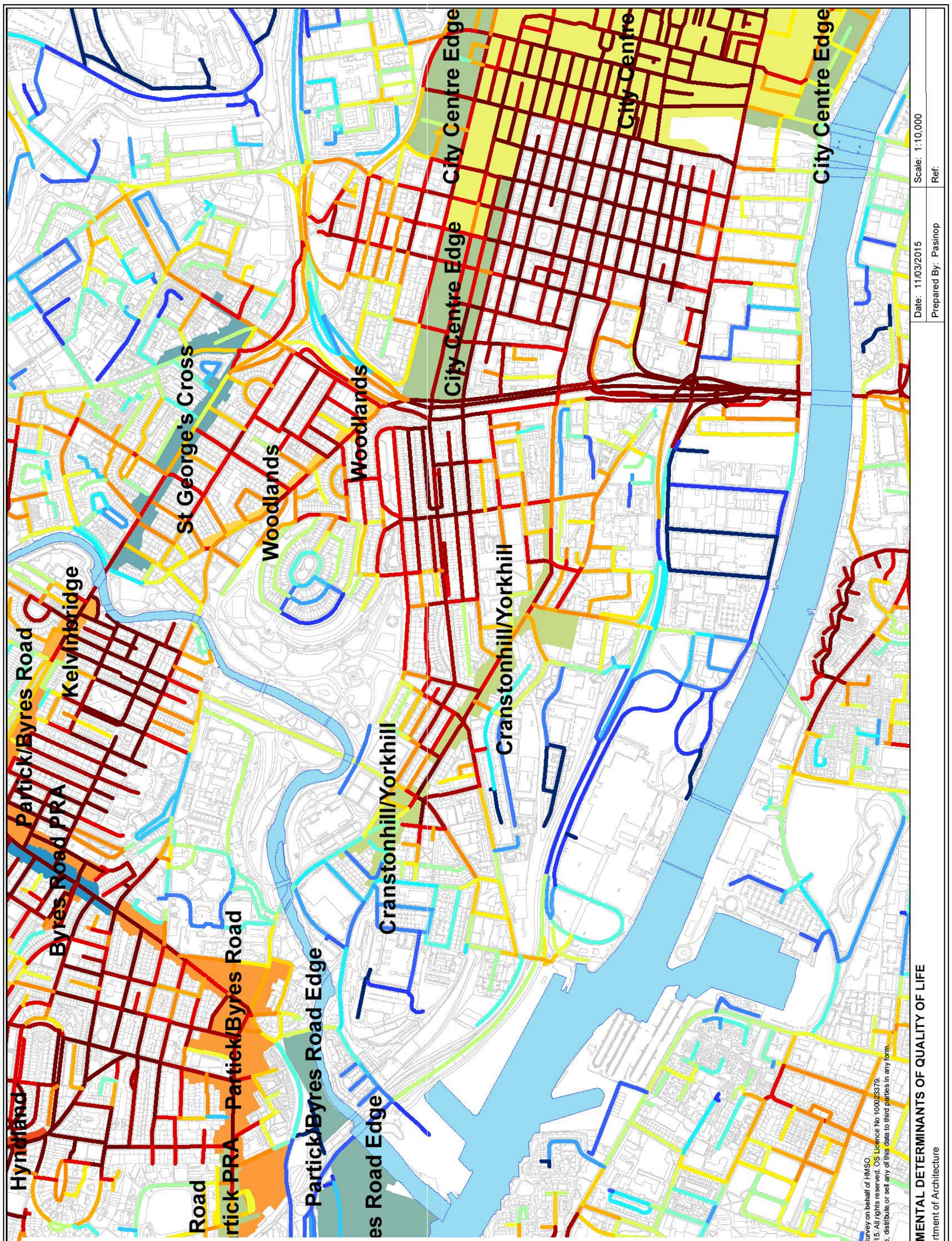


Figure 220. Closeness @400 Centrality Index. Town Centre: Cranstonhill_Yorkhill.pdf

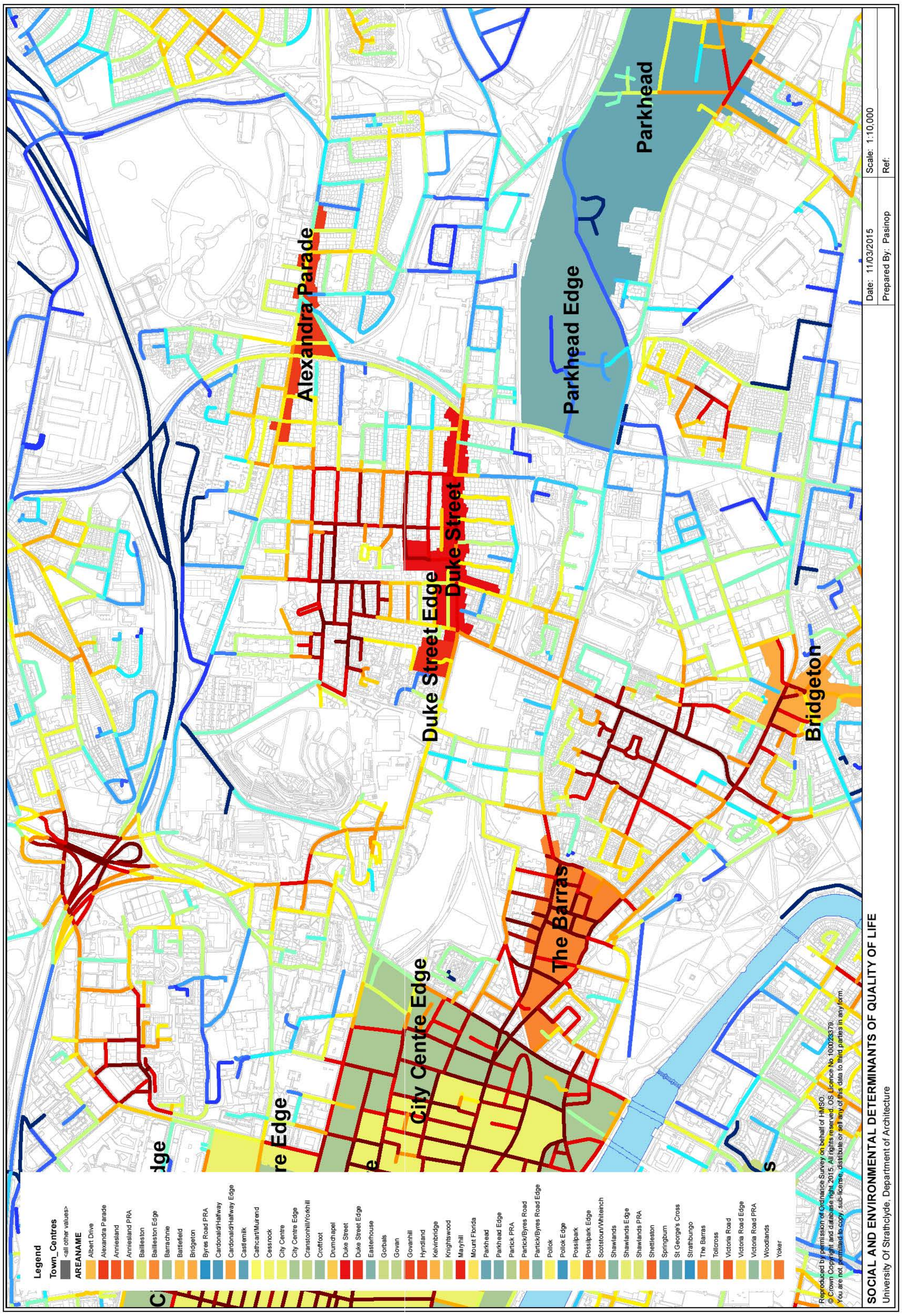


Figure 221. Closeness @400 Centrality Index. Town Centre: Duke Street Edge.pdf

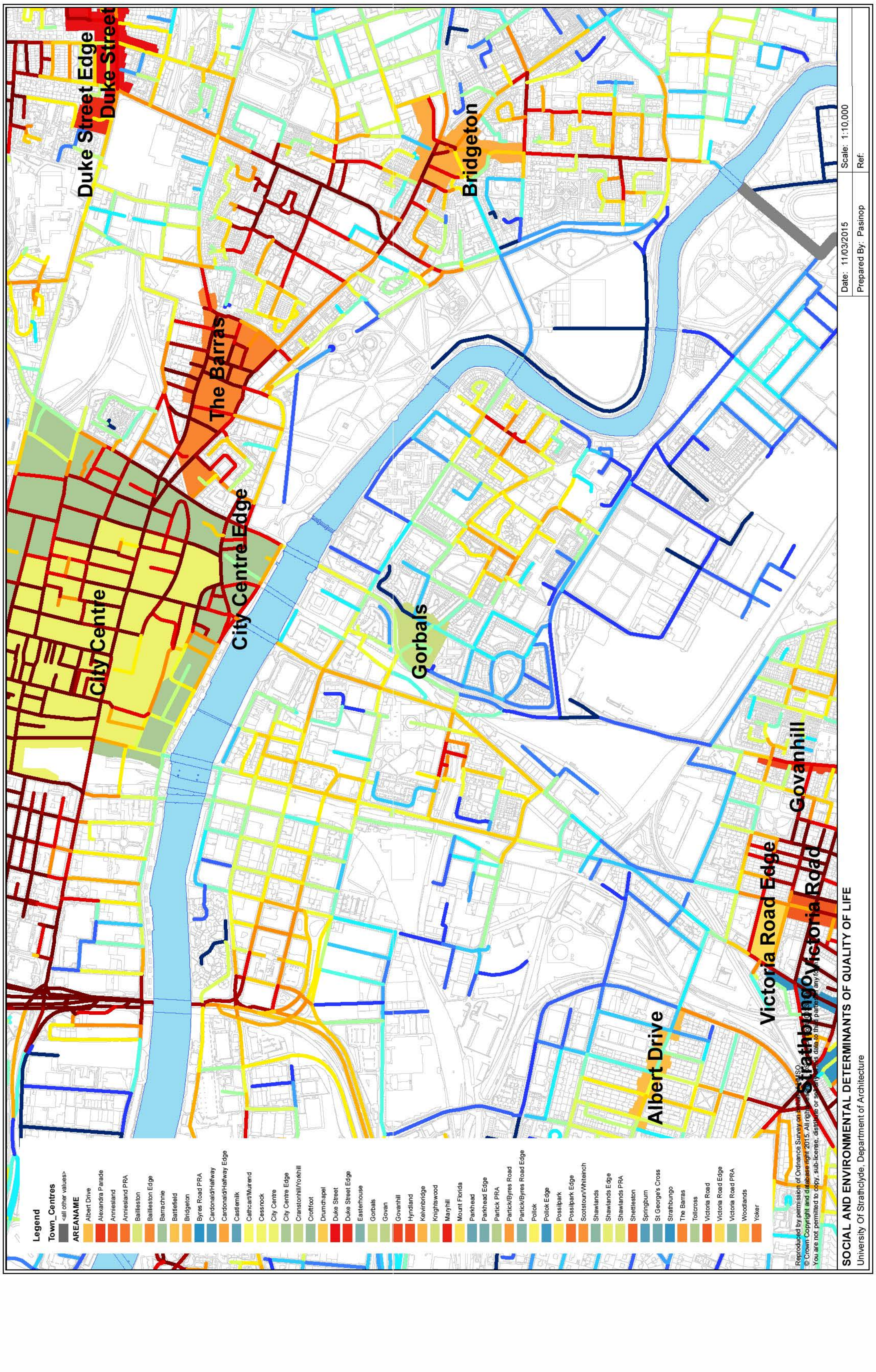


Figure 222. *Closeness @400 Centrality Index. Town Centre: Gorbals.pdf*

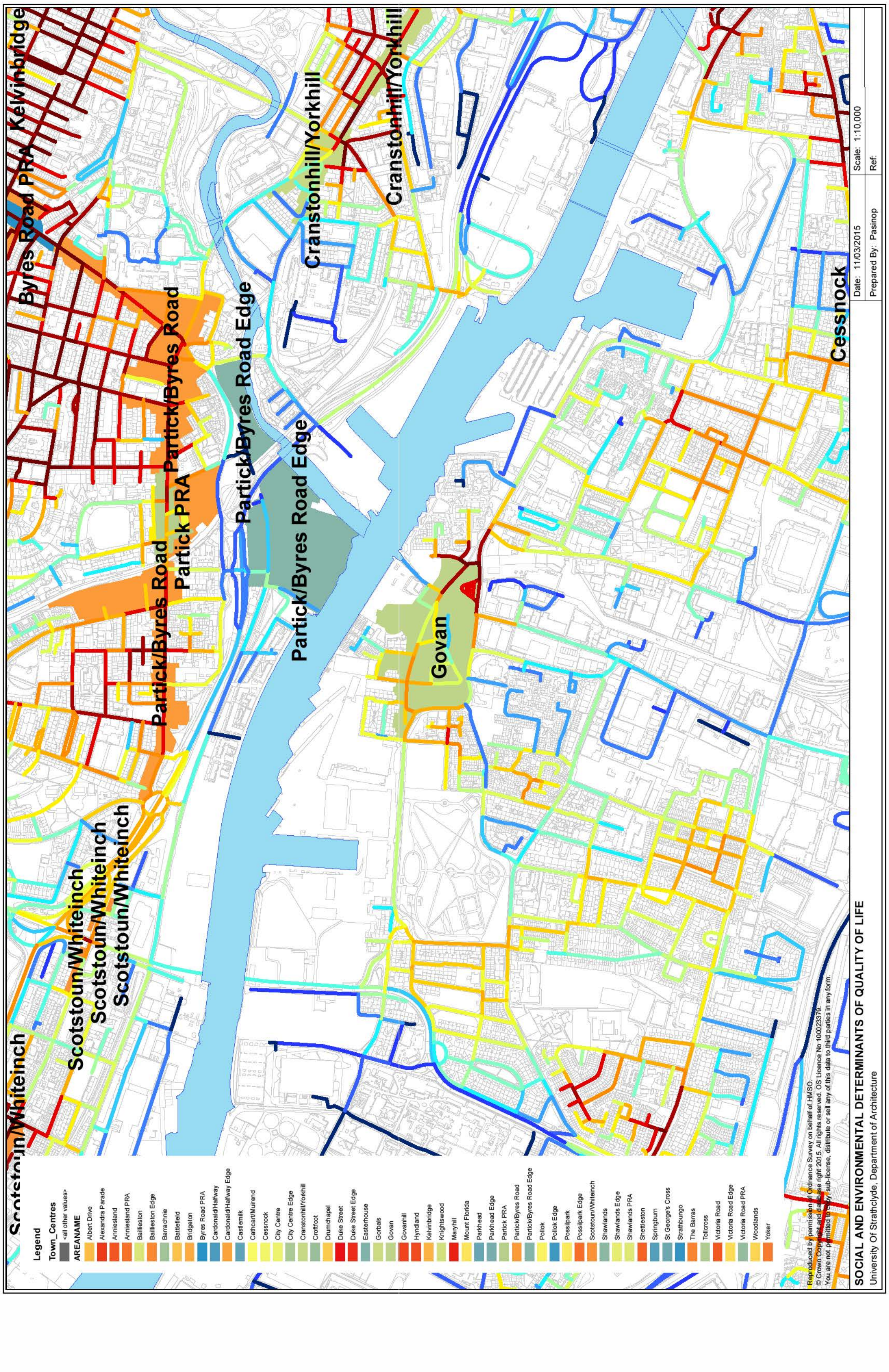


Figure 223. Closeness @400 Centrality Index. Town Centre: Govan.pdf

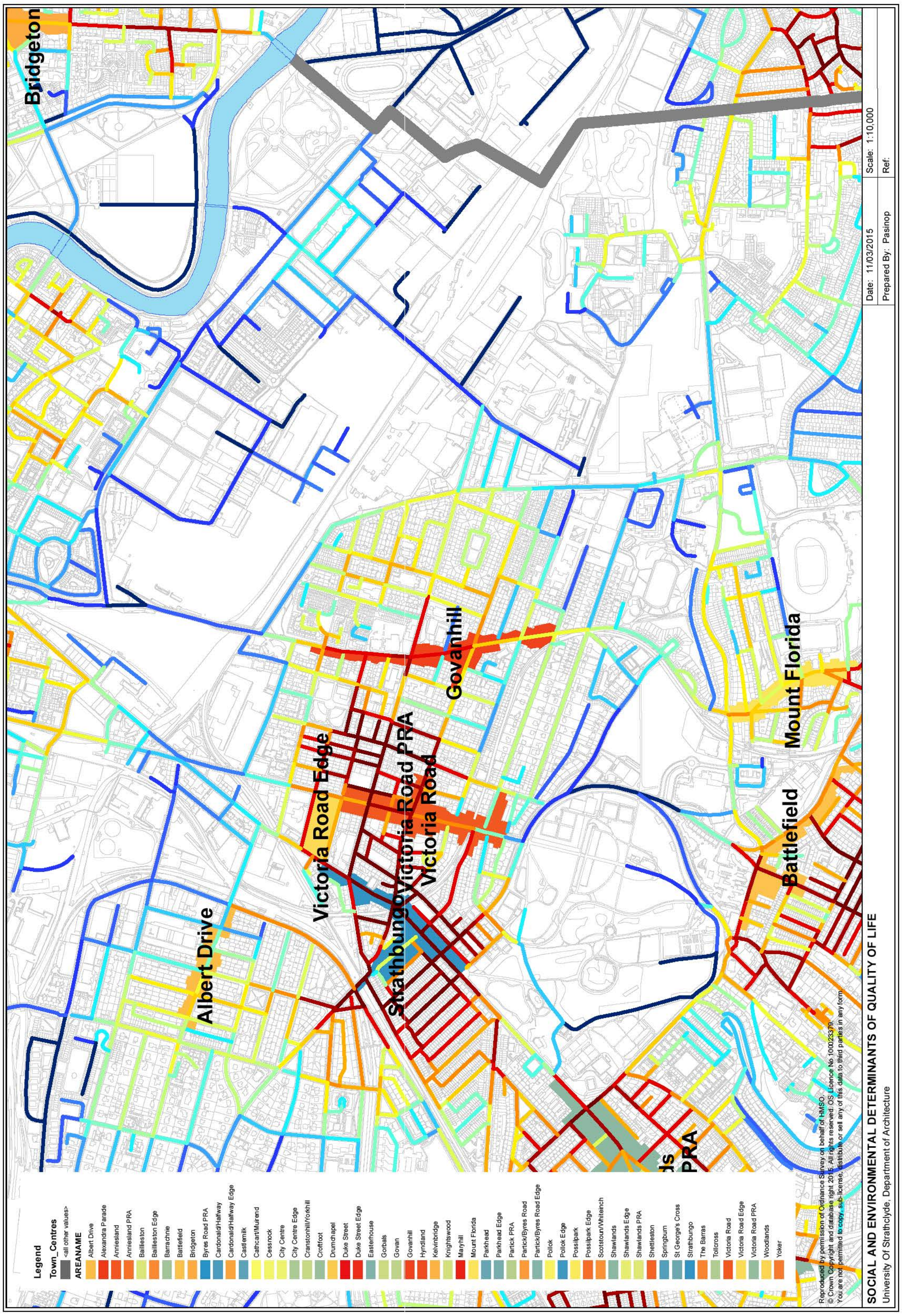


Figure 224. Closeness @400 Centrality Index. Town Centre: Govanhill.pdf

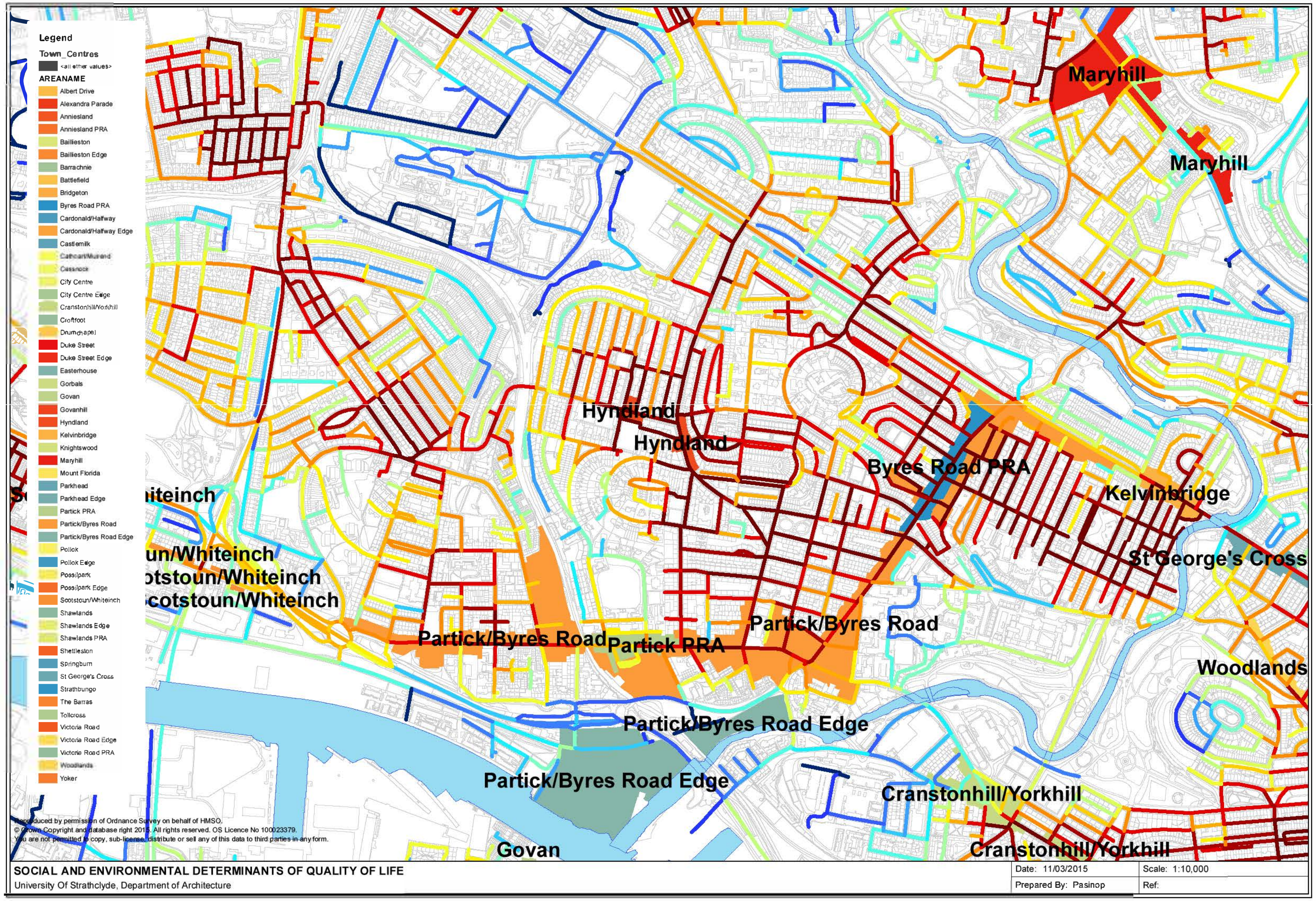


Figure 225. Closeness @400 Centrality Index: Town Centre: Hyndland.pdf

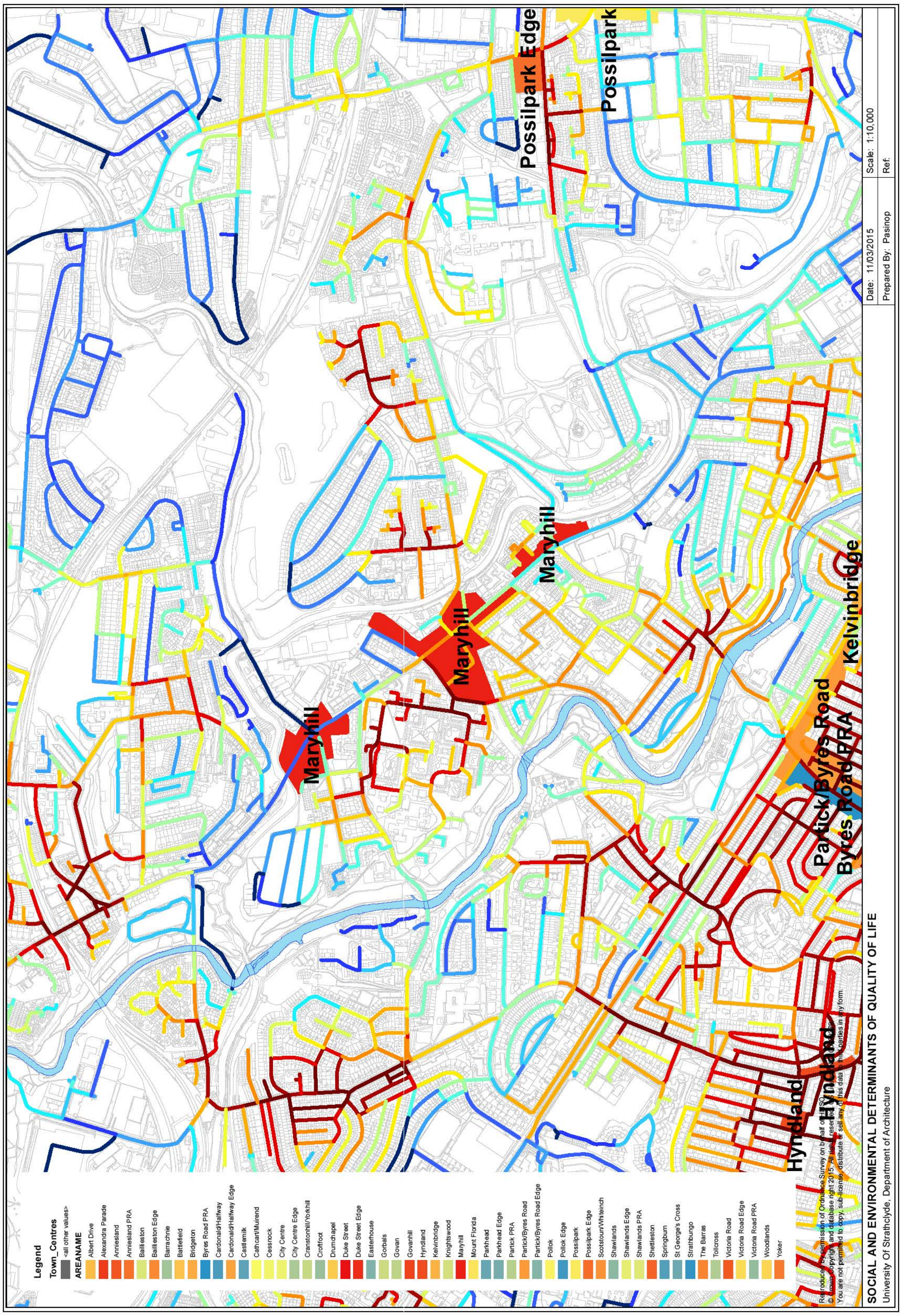


Figure 226. Closeness @400 Centrality Index. Town Centre: Maryhill.pdf

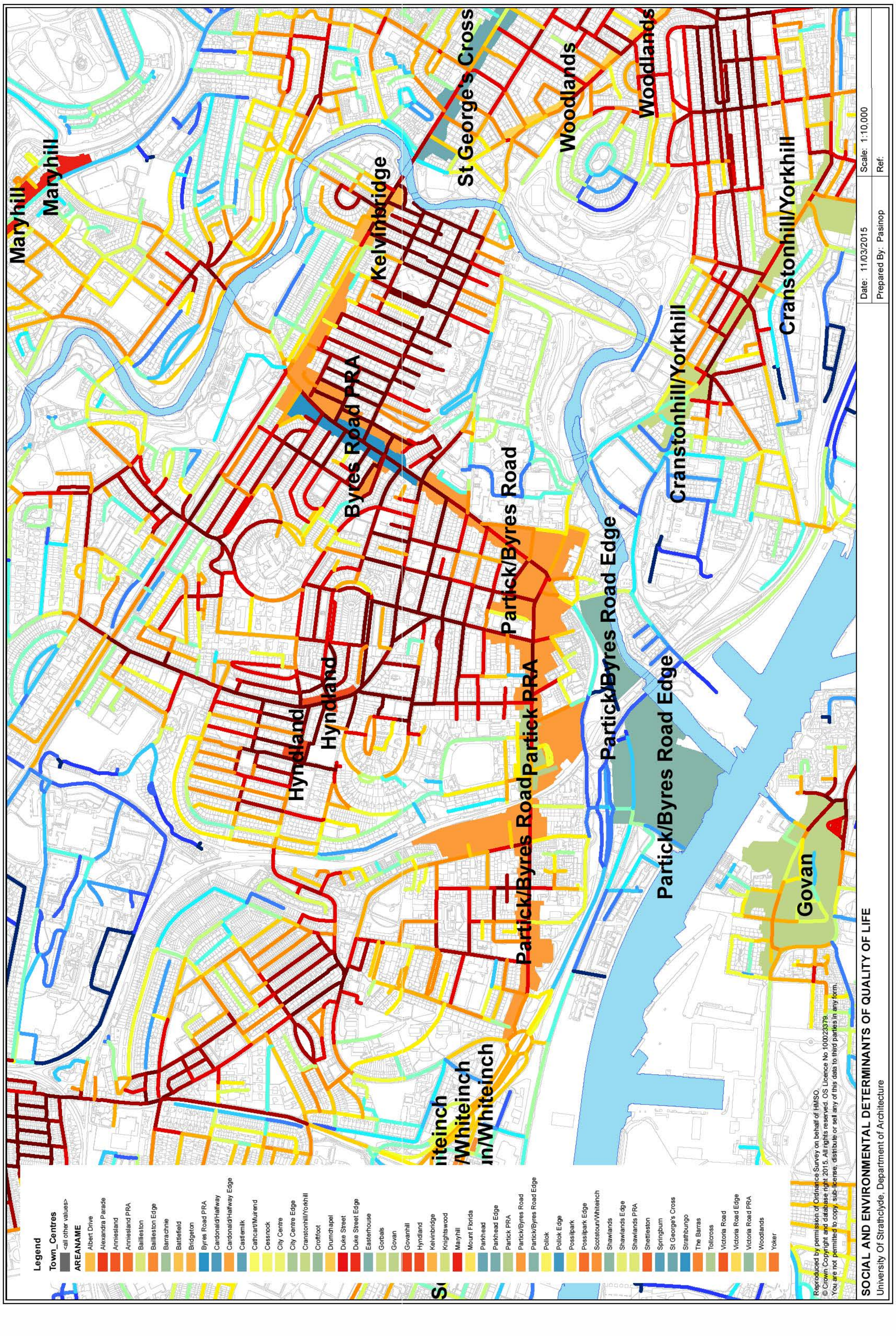


Figure 227. Closeness @400 Centrality Index. Town Centre: Partick_Byres Road.pdf

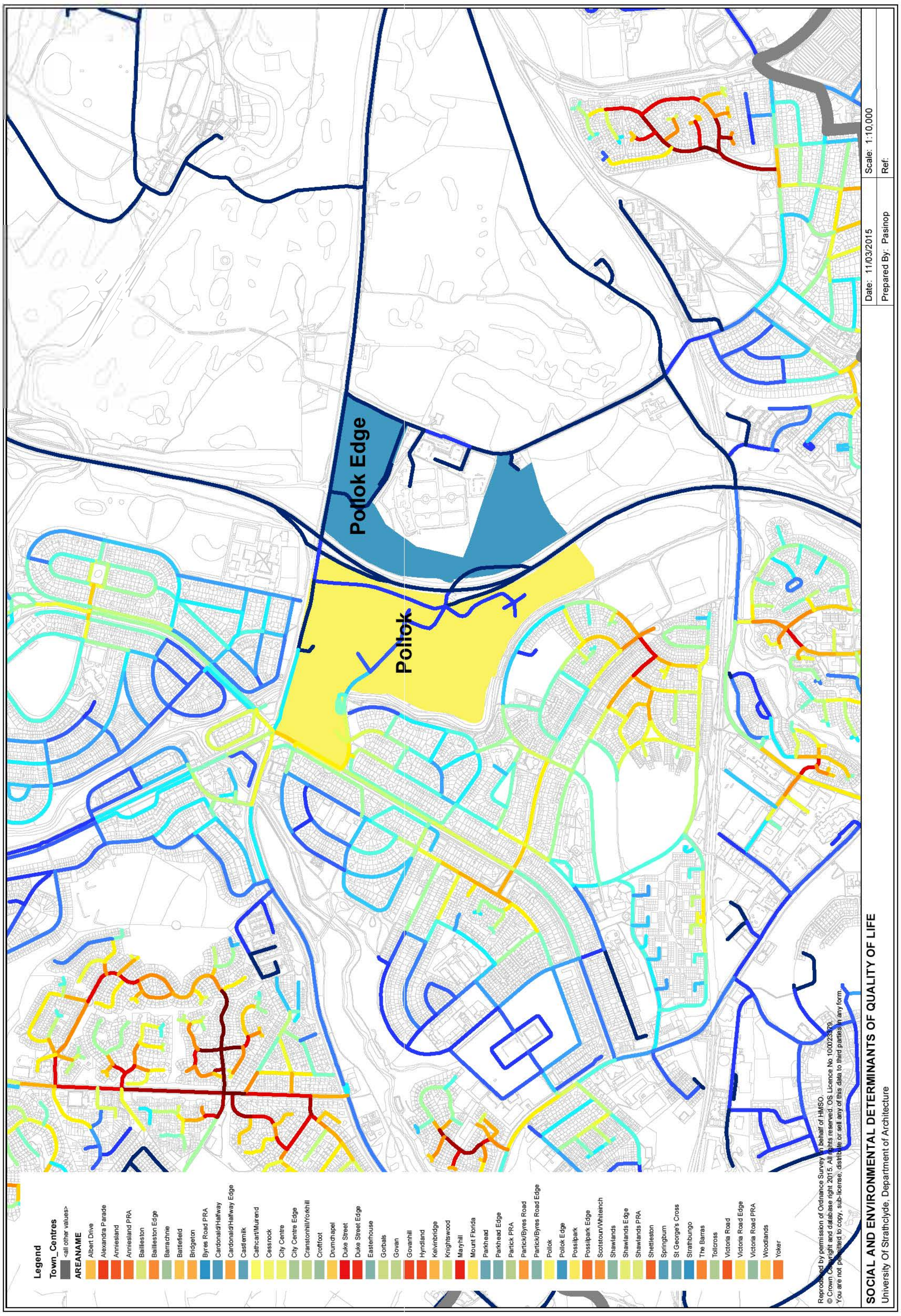


Figure 228. *Closeness @400 Centrality Index. Town Centre: Pollok.pdf*

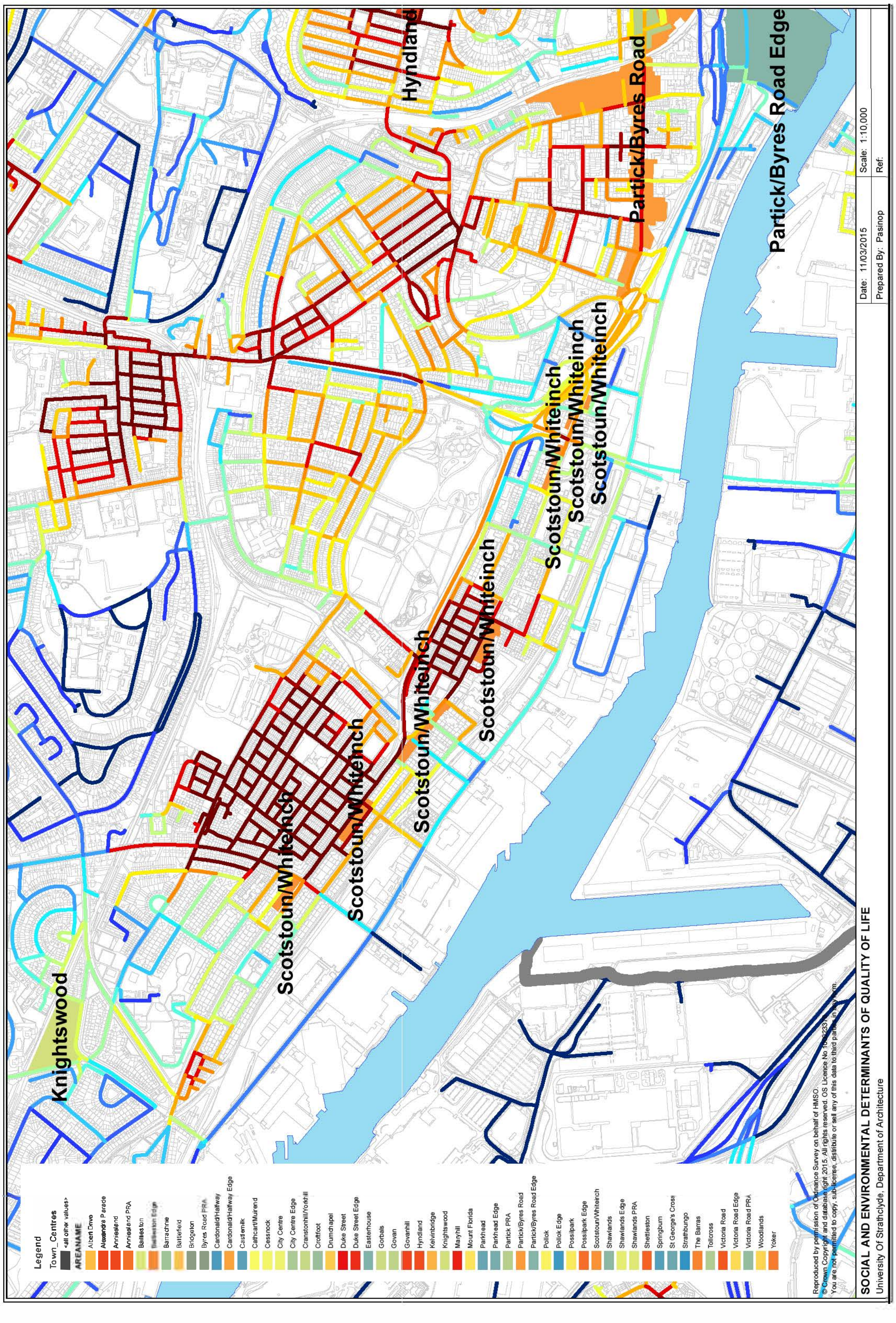


Figure 229. *Closeness @400 Centrality Index. Town Centre: Scotstoun_Whiteinch.pdf*

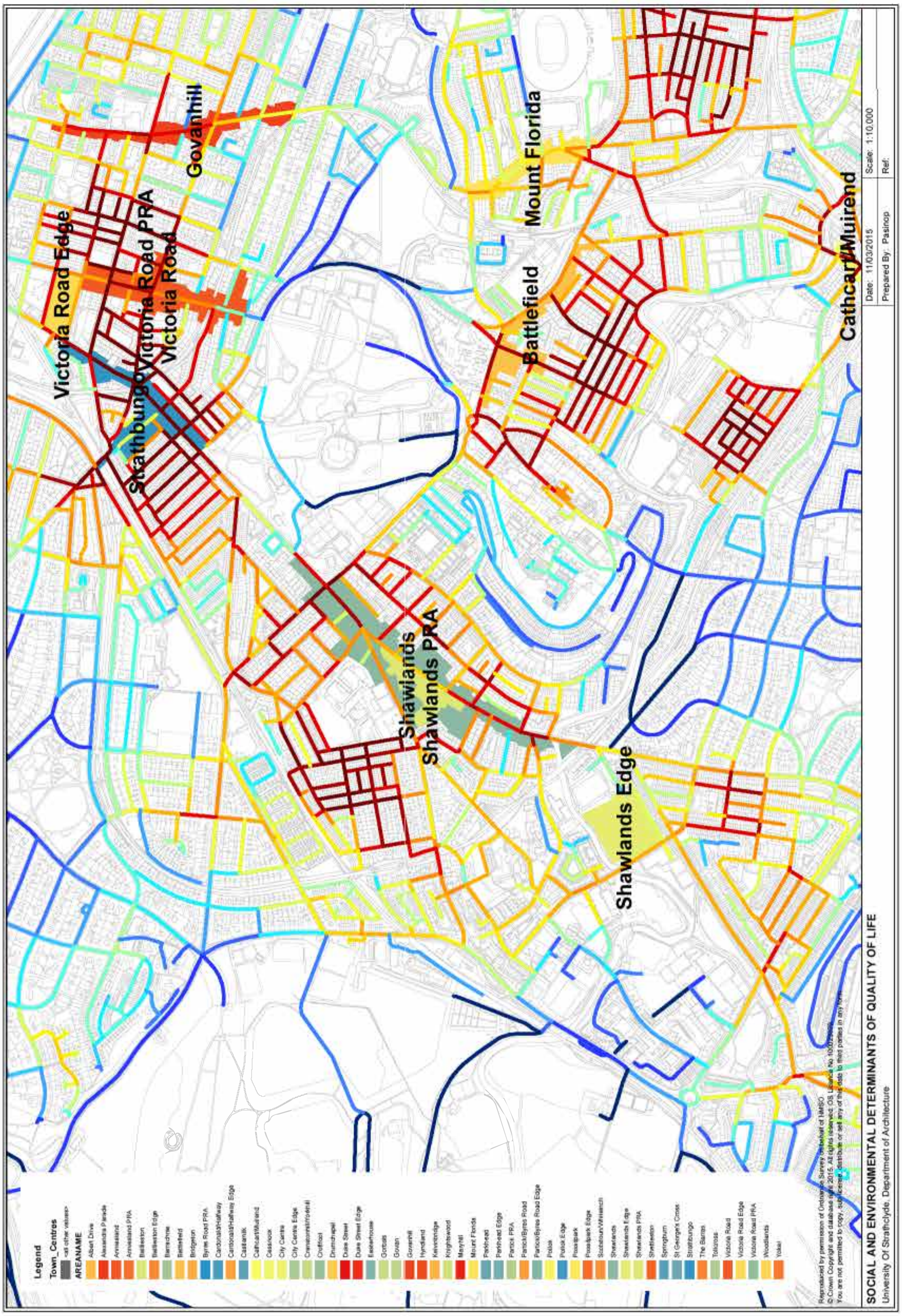


Figure 230. *Closeness @400 Centrality Index. Town Centre: Shawlands.pdf*

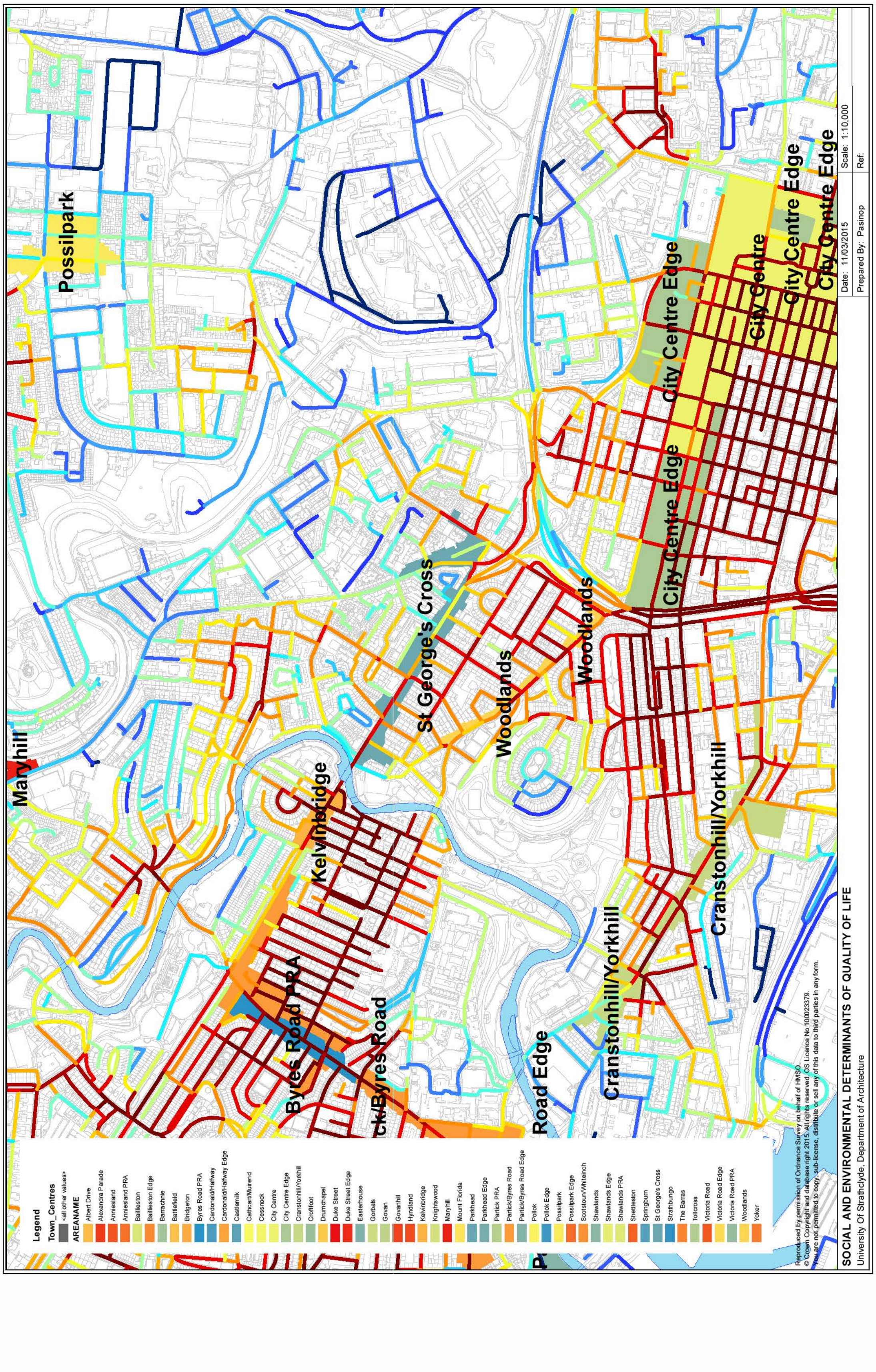


Figure 231. Closeness @400 Centrality Index. Town Centre: St George's Cross.pdf

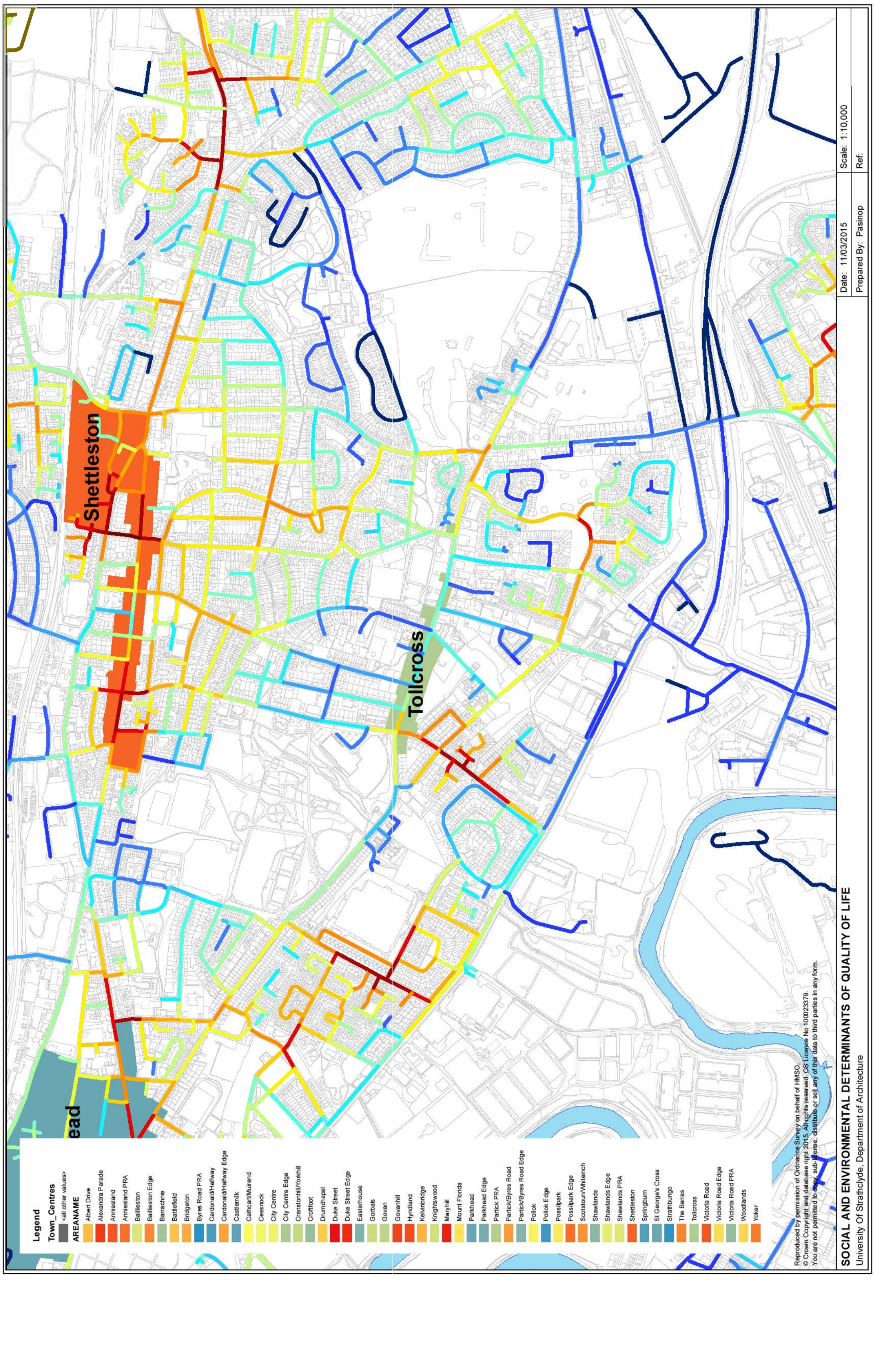


Figure 232. Closeness @400 Centrality Index. Town Centre: Tollcross.pdf

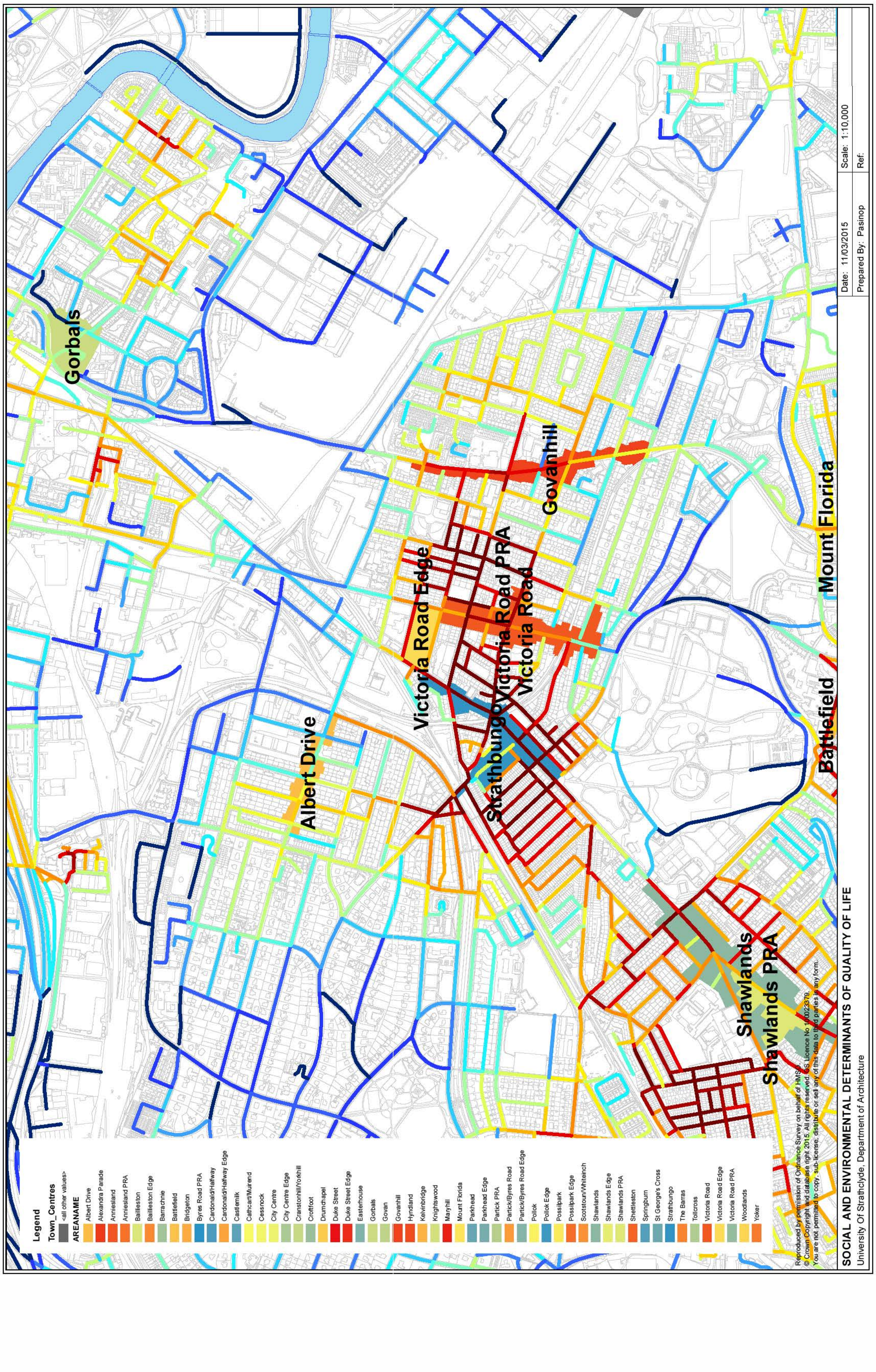


Figure 233. Closeness @400 Centrality Index. Town Centre: Victoria Road Edge.pdf

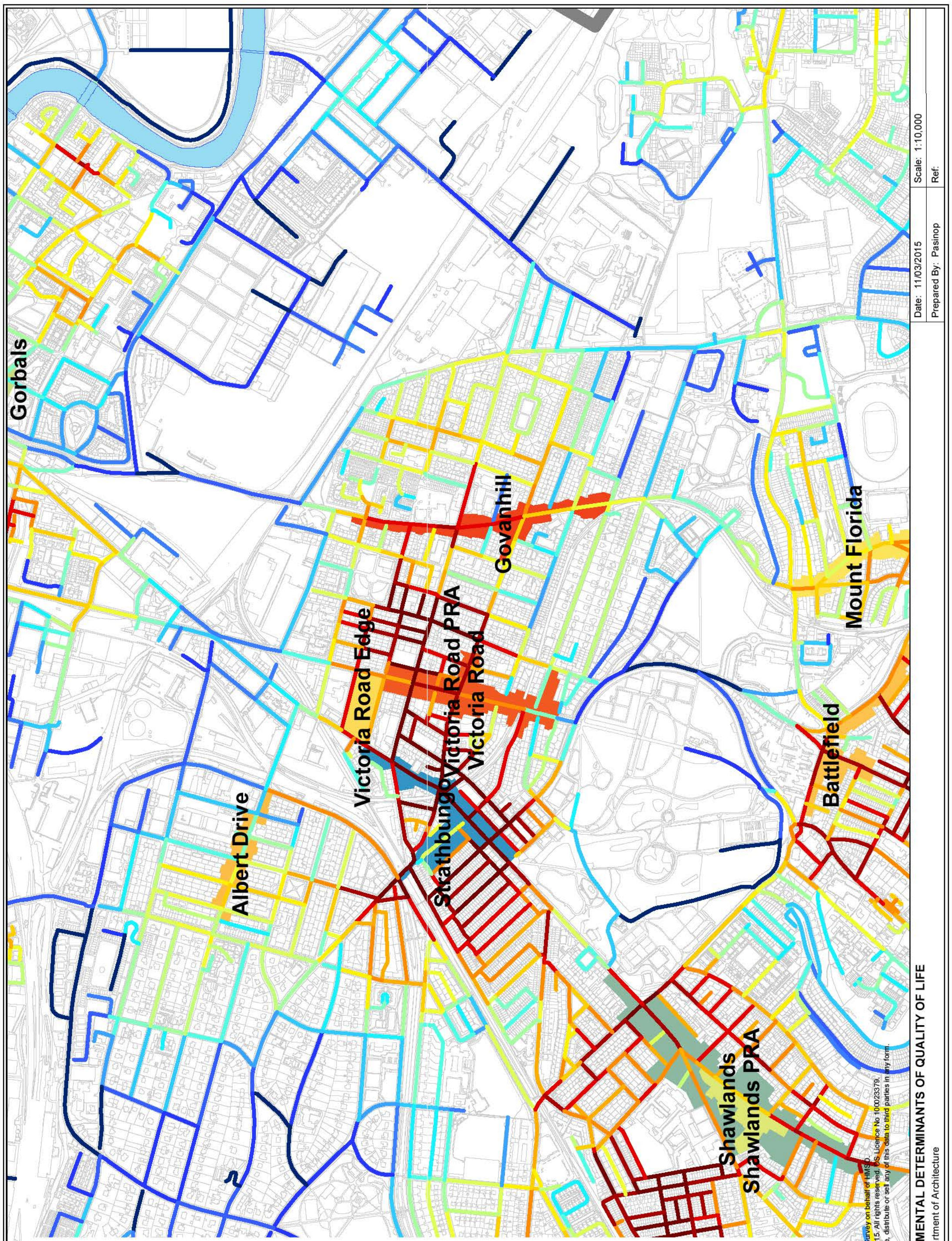


Figure 234. Closeness @400 Centrality Index. Town Centre: Victoria Road PRA.pdf

Figure 235. *Closeness @400 Centrality Index. Town Centre: Woodlands.pdf*

8.4. Appendix 2: Town Centres and Closeness @ 400m index, exceptions

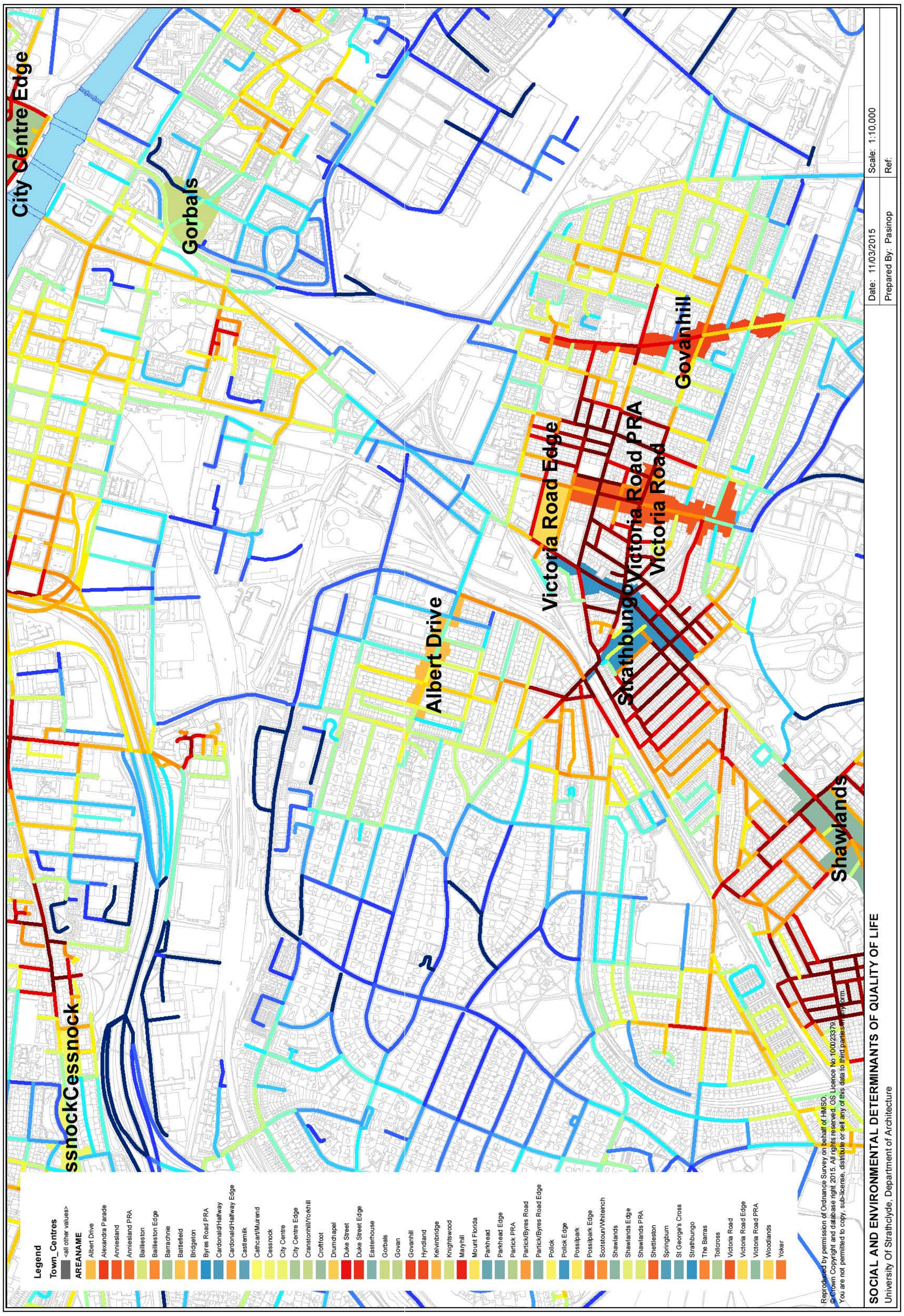


Figure 236. Closeness @400 Centrality Index. Town Centre: Albert Drive.pdf

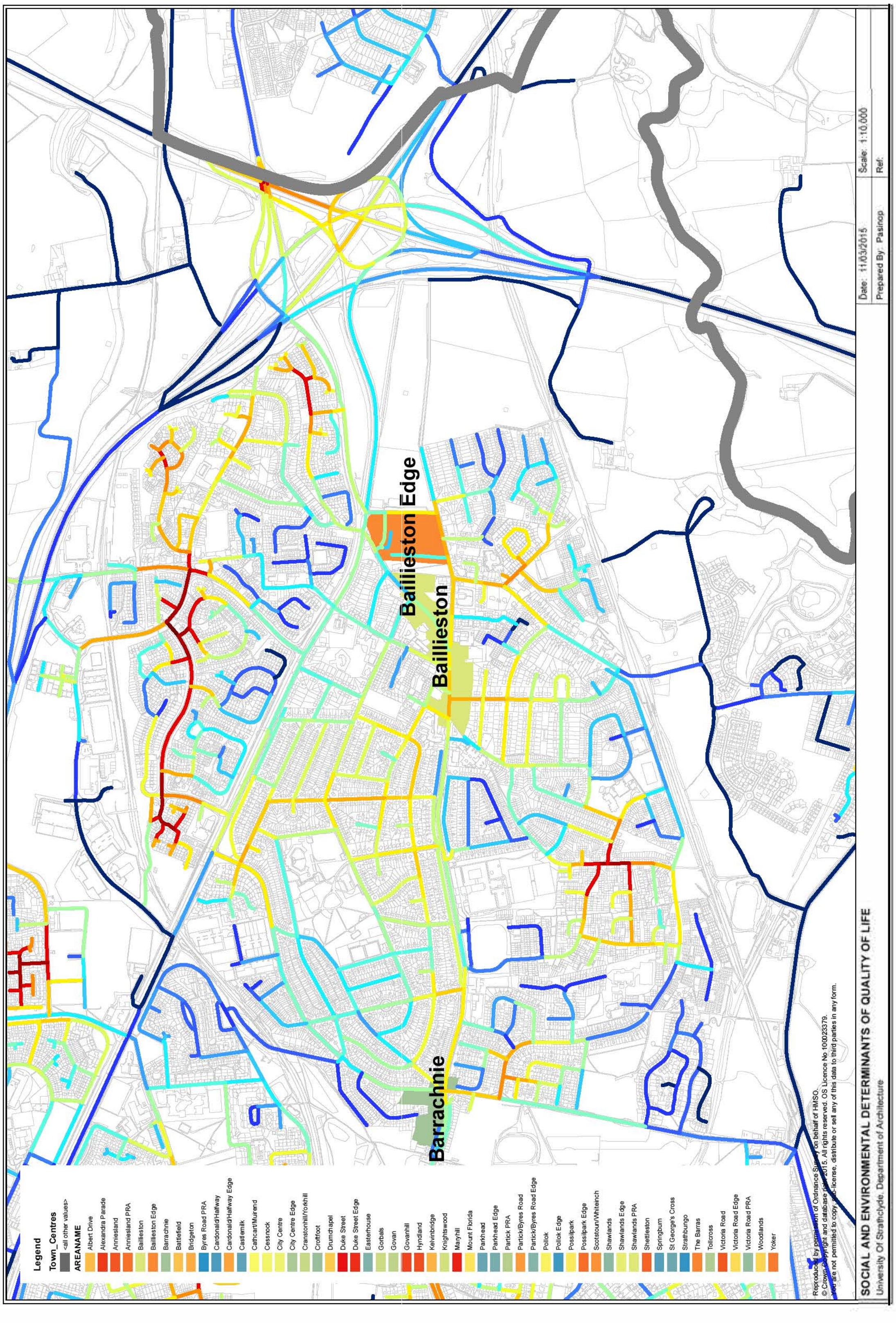


Figure 237. Closeness @400 Centrality Index. Town Centre: Baillieston.pdf

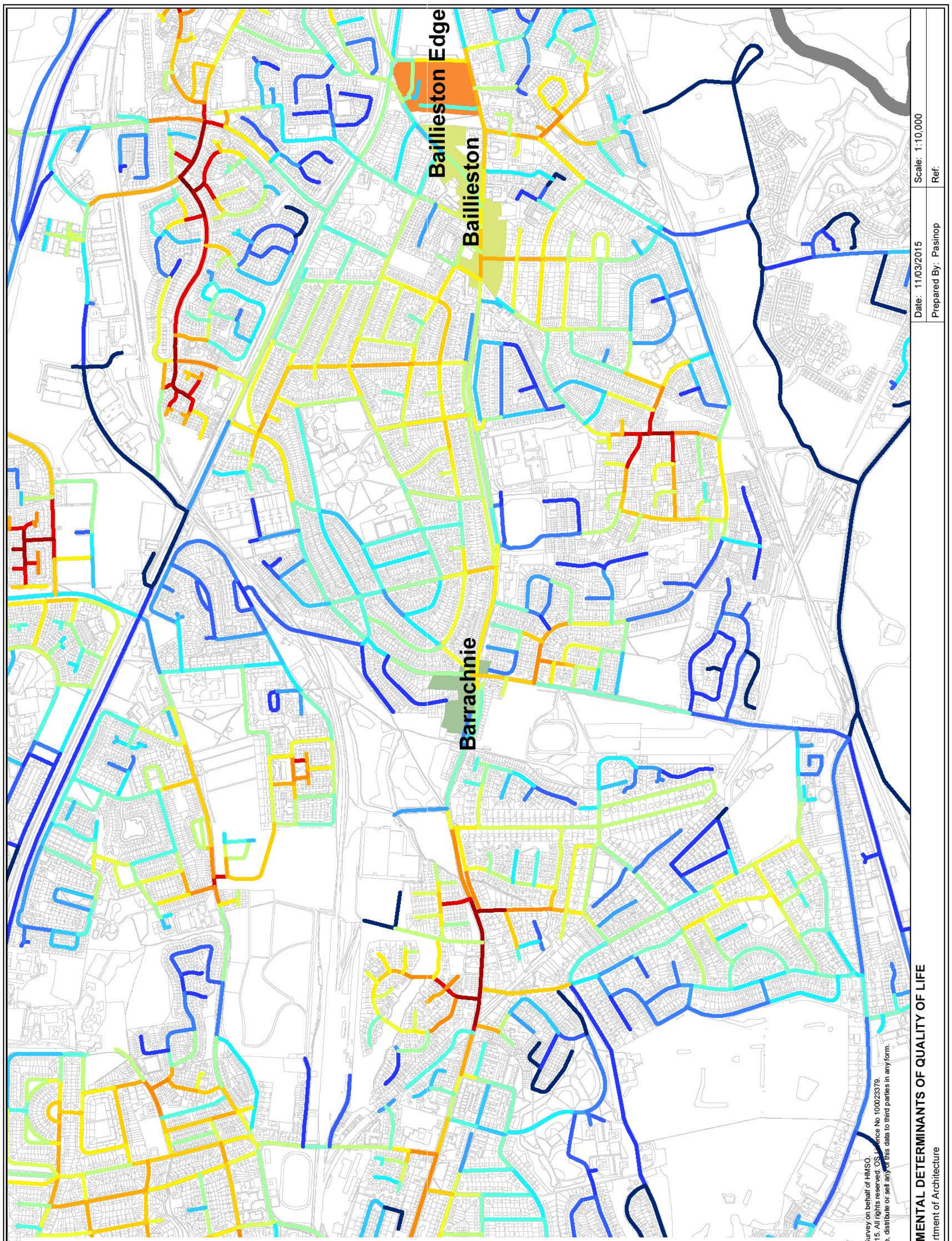


Figure 238. Closeness @400 Centrality Index. Town Centre: Barrachnie.pdf

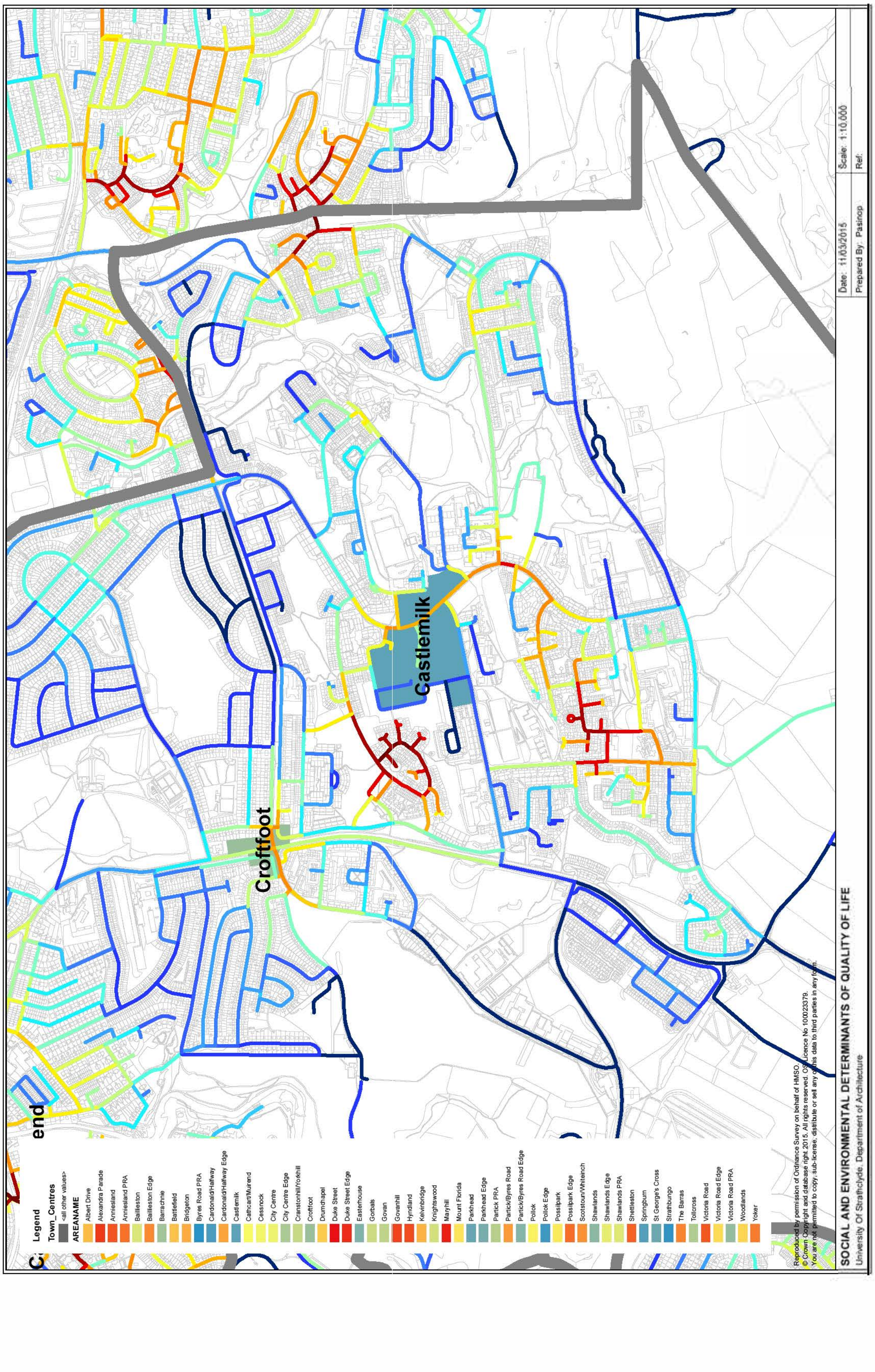


Figure 239. *Closeness @400 Centrality Index. Town Centre: Castlemilk.pdf*

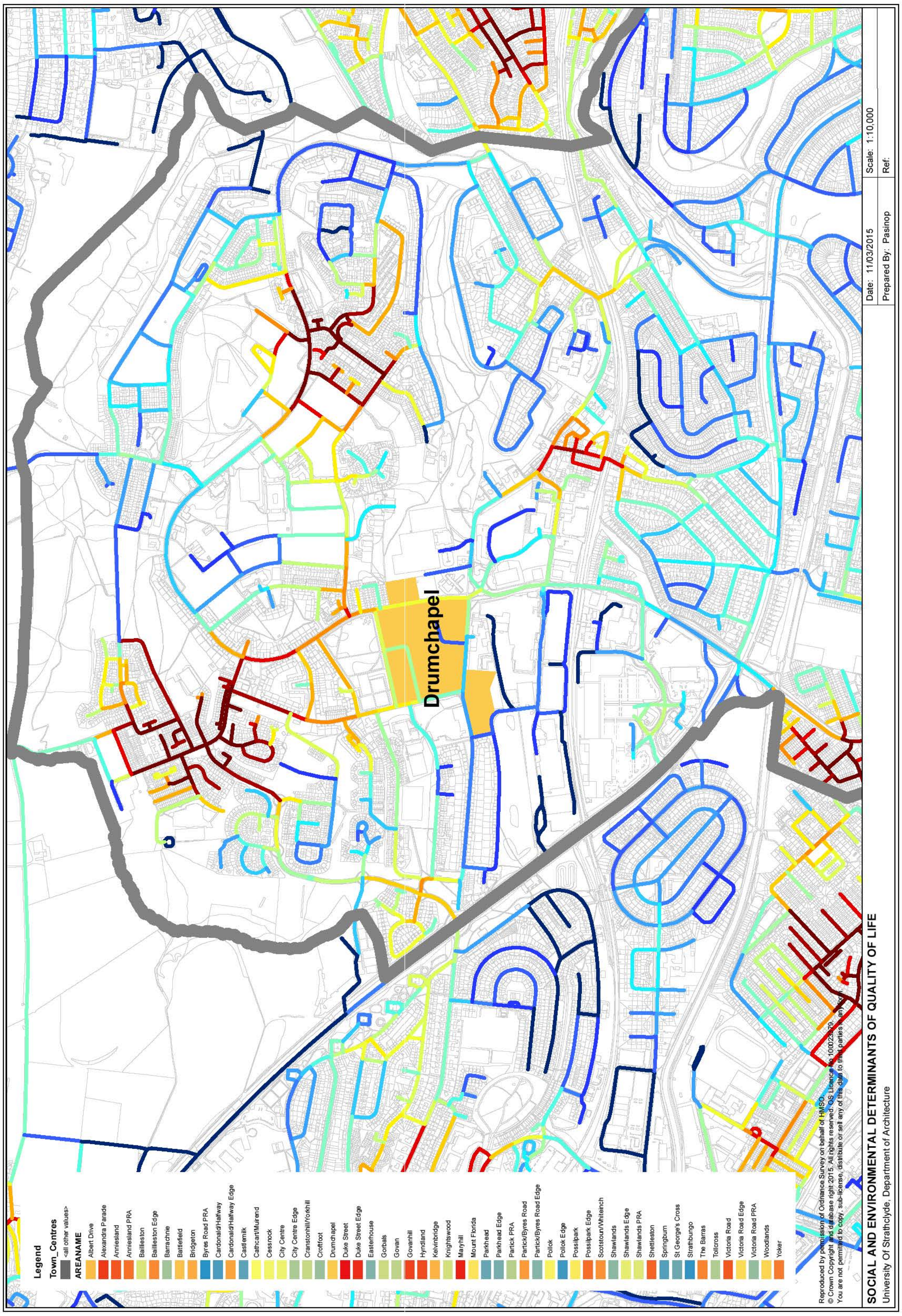


Figure 240. Closeness @400 Centrality Index. Town Centre: Drumchapel.pdf

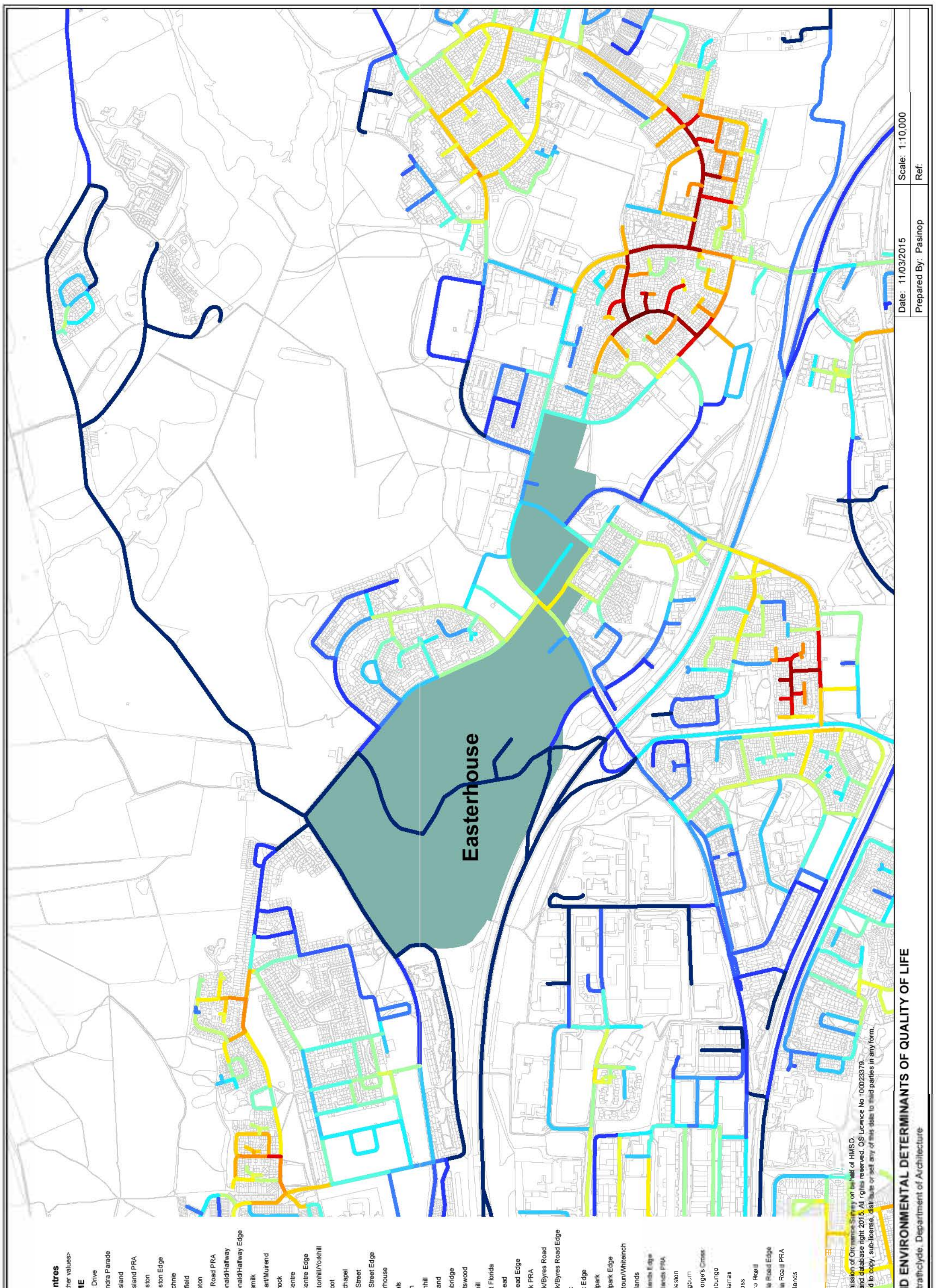


Figure 241. Closeness @400 Centrality Index. Town Centre: Easterhouse.pdf

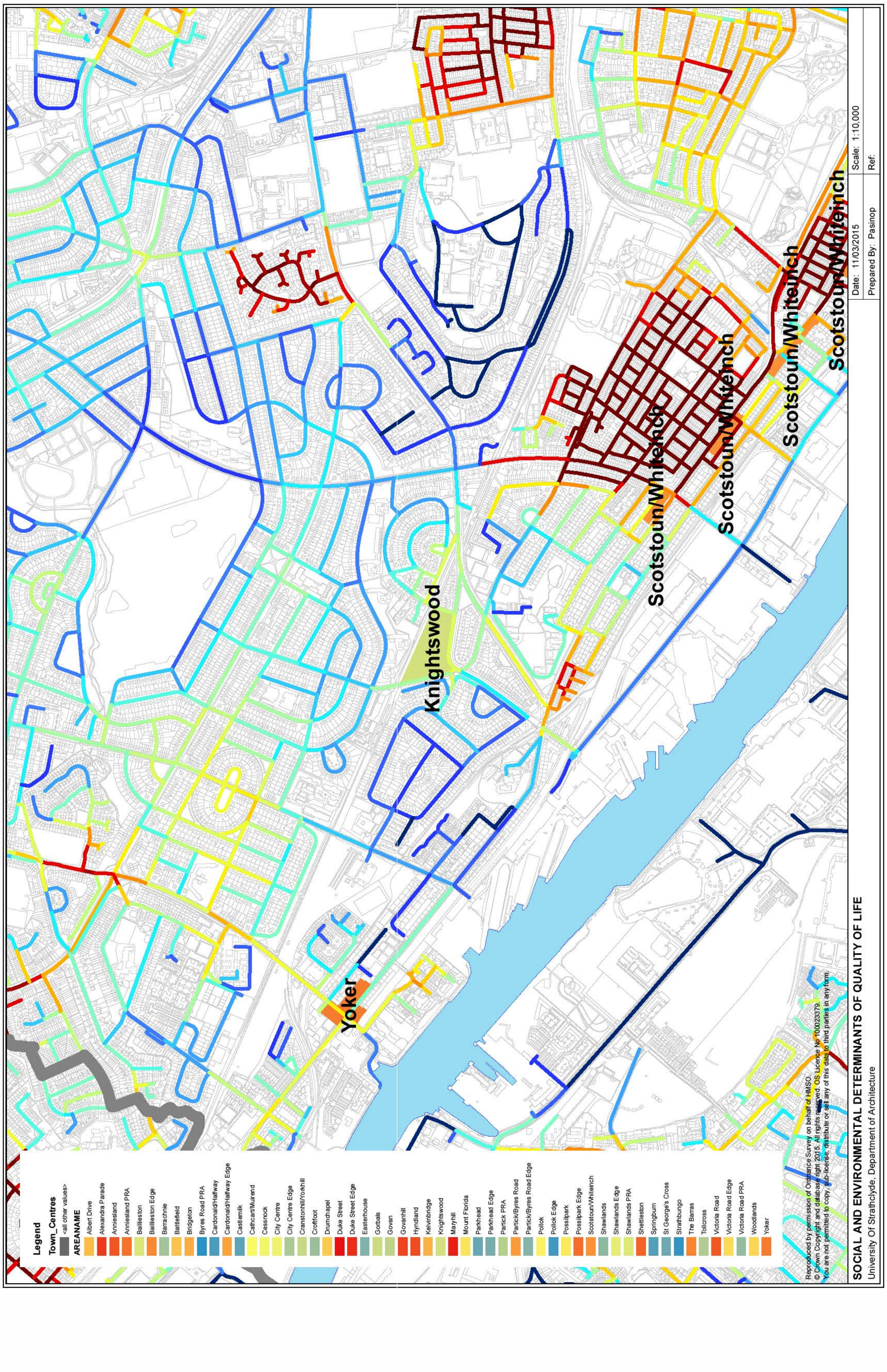


Figure 242. Closeness @400 Centrality Index. Town Centre: Knightswood.pdf

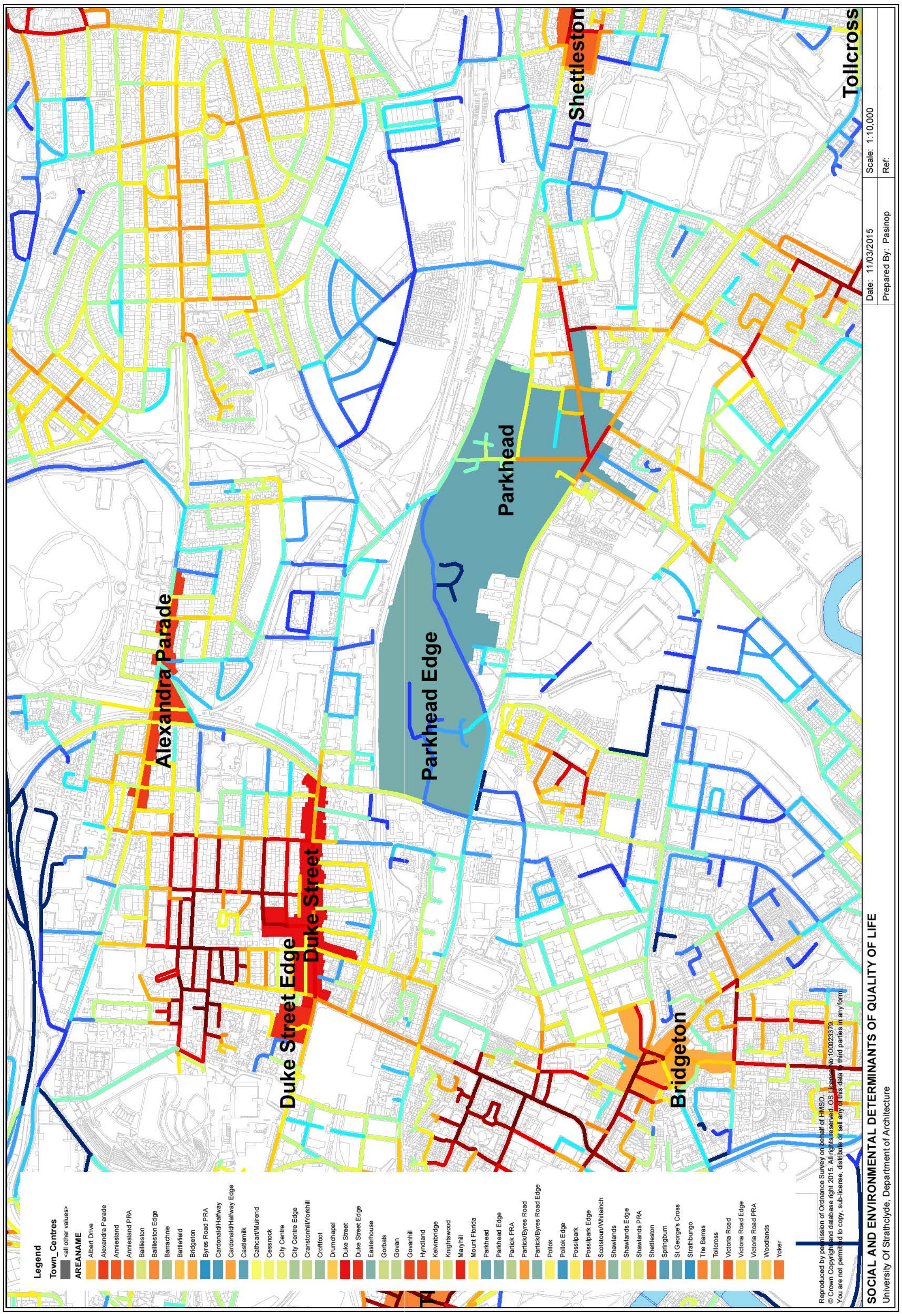


Figure 243. *Closeness @400 Centrality Index. Town Centre: Parkhead Edge.pdf*

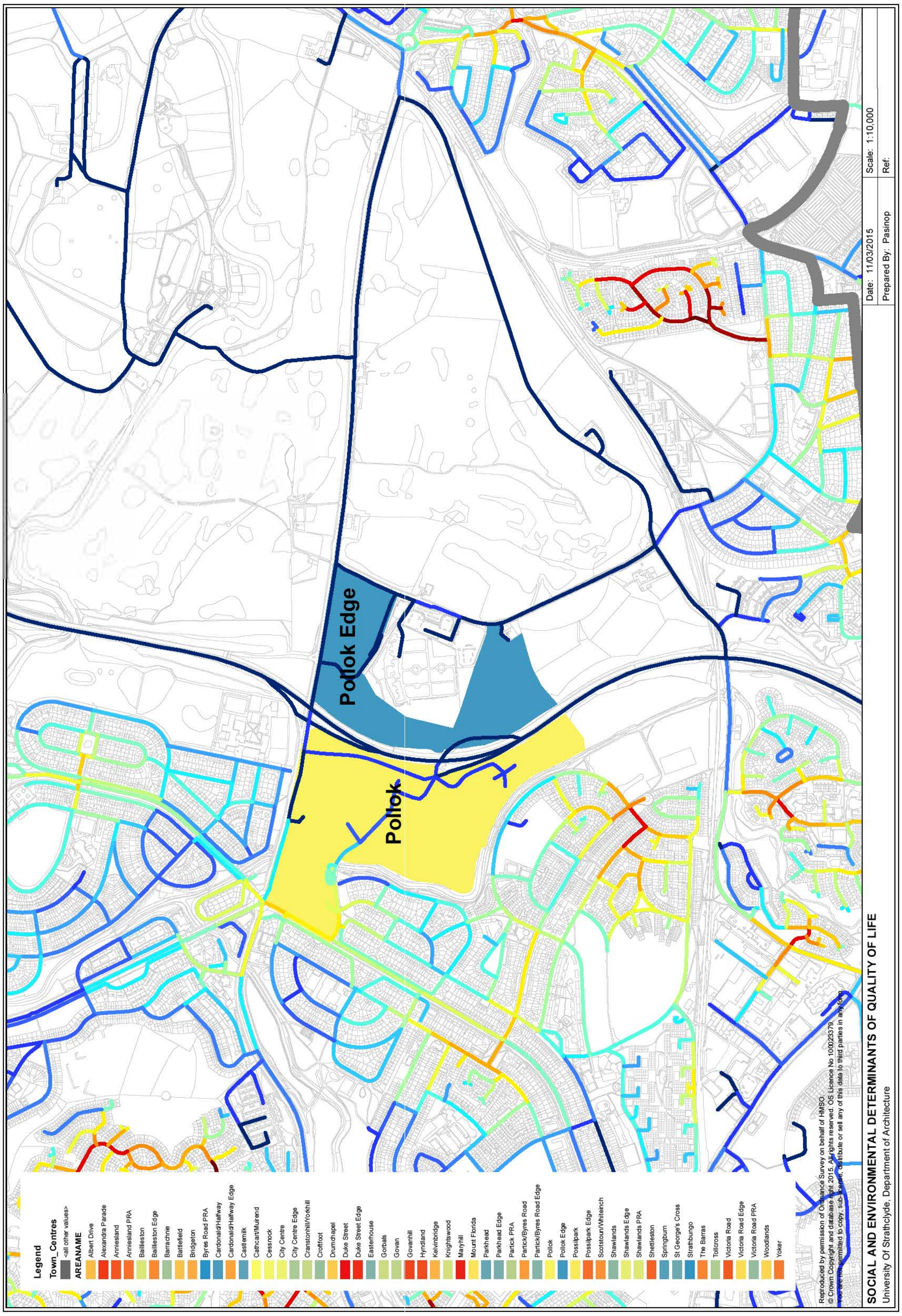


Figure 244. Closeness @400 Centrality Index. Town Centre: Pollok Edge.pdf

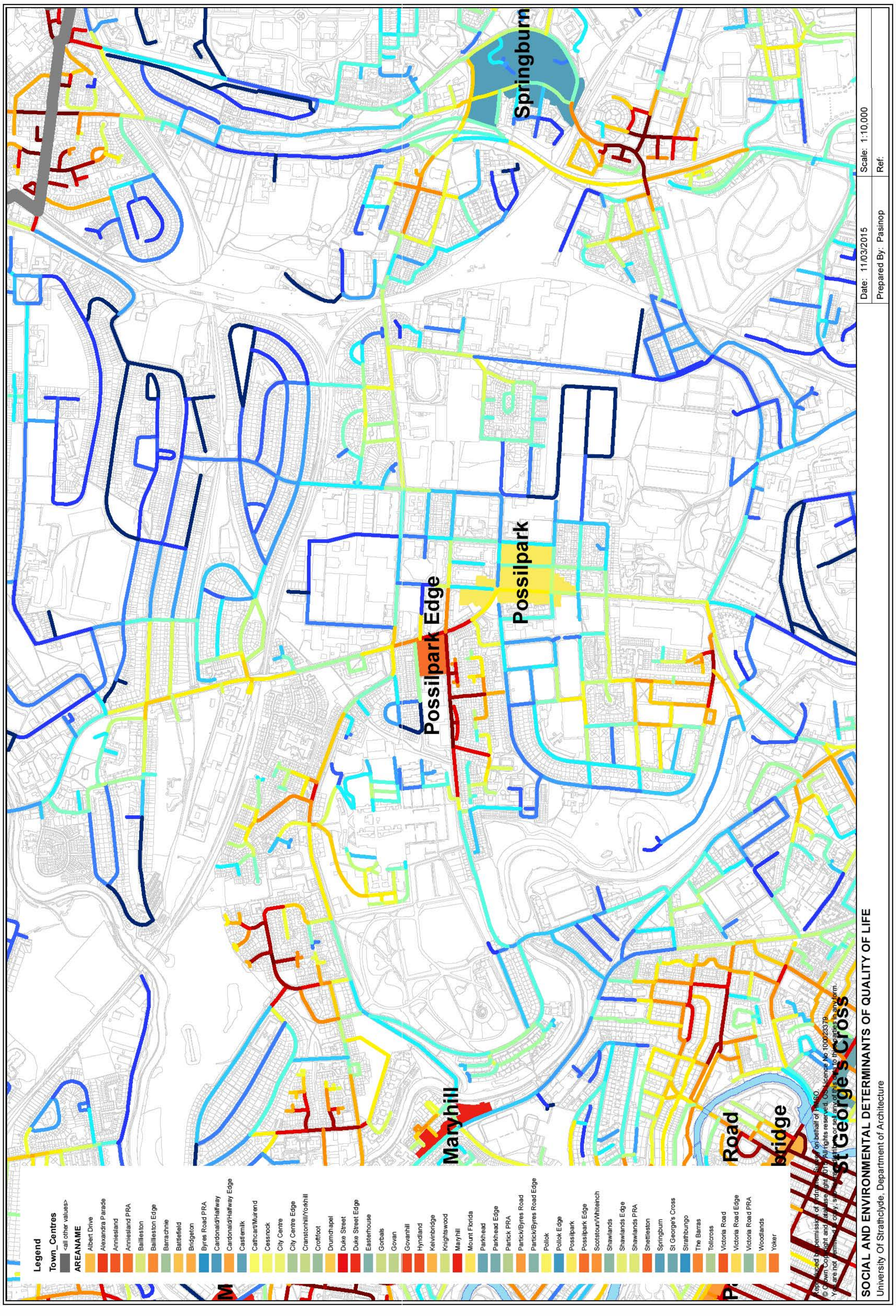


Figure 245. *Closeness @400 Centrality Index. Town Centre: Possilpark Edge.pdf*

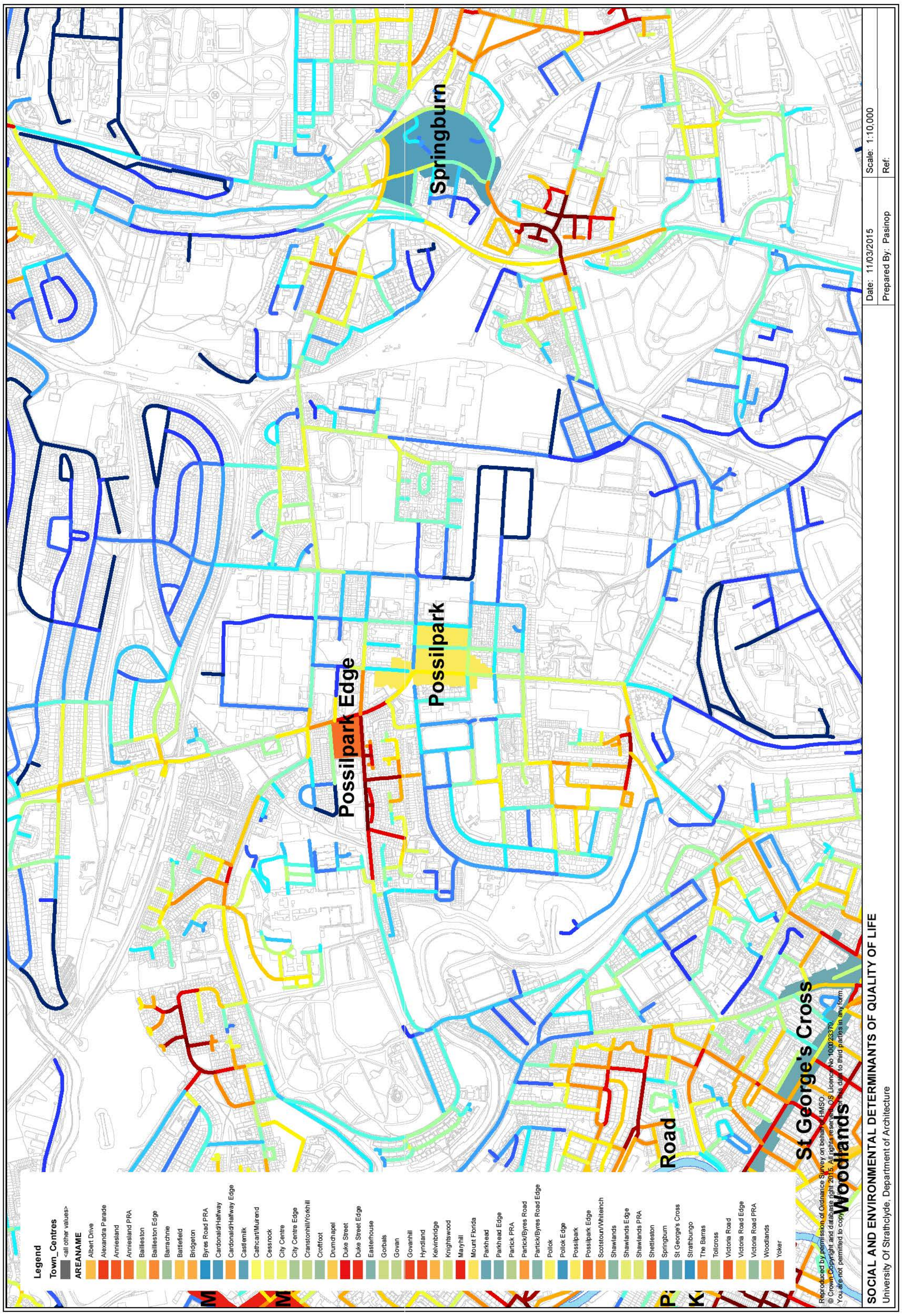


Figure 246. Closeness @400 Centrality Index. Town Centre: Possilpark.pdf

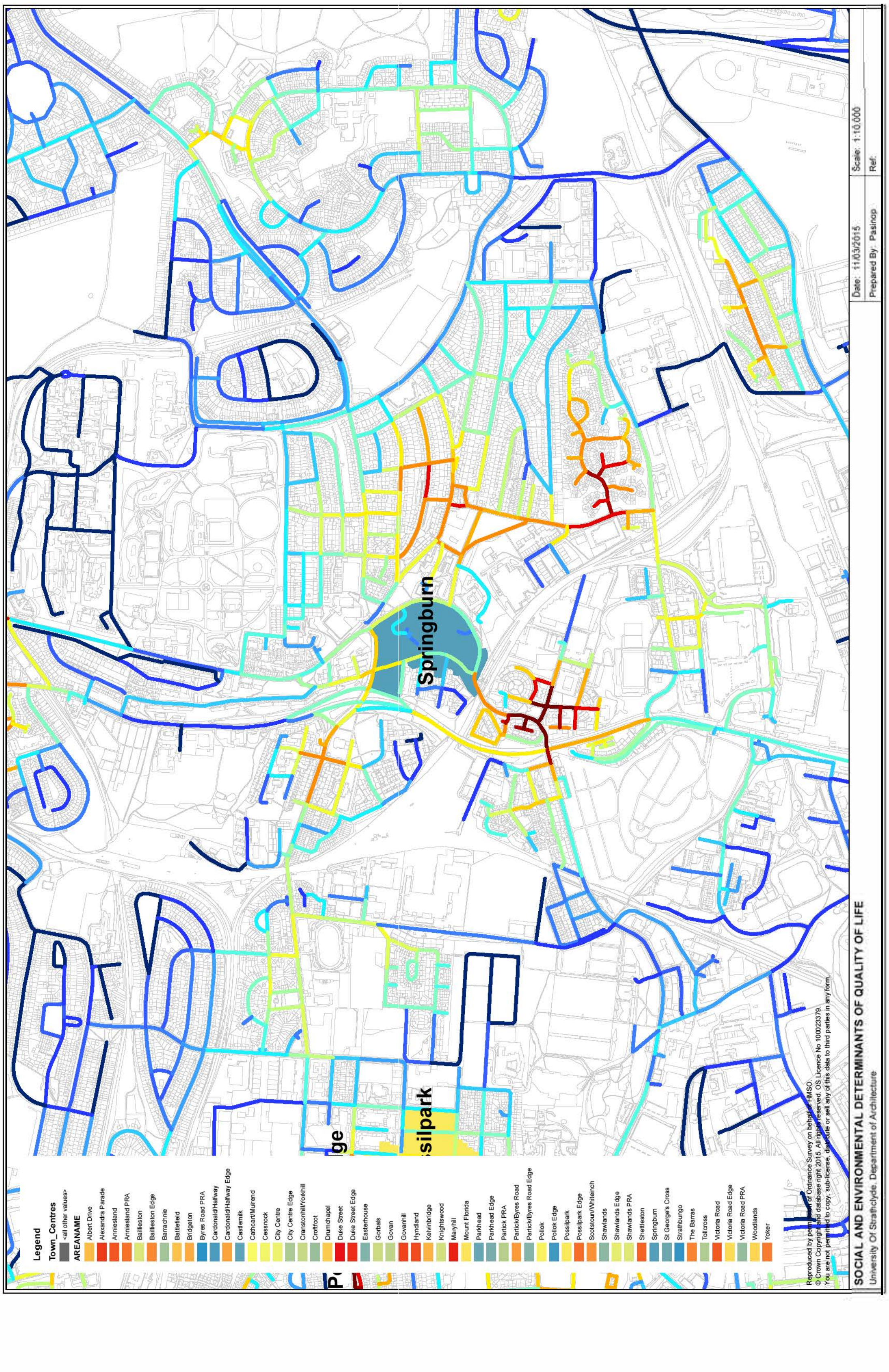


Figure 247. Closeness @400 Centrality Index. Town Centre: Springburn.pdf

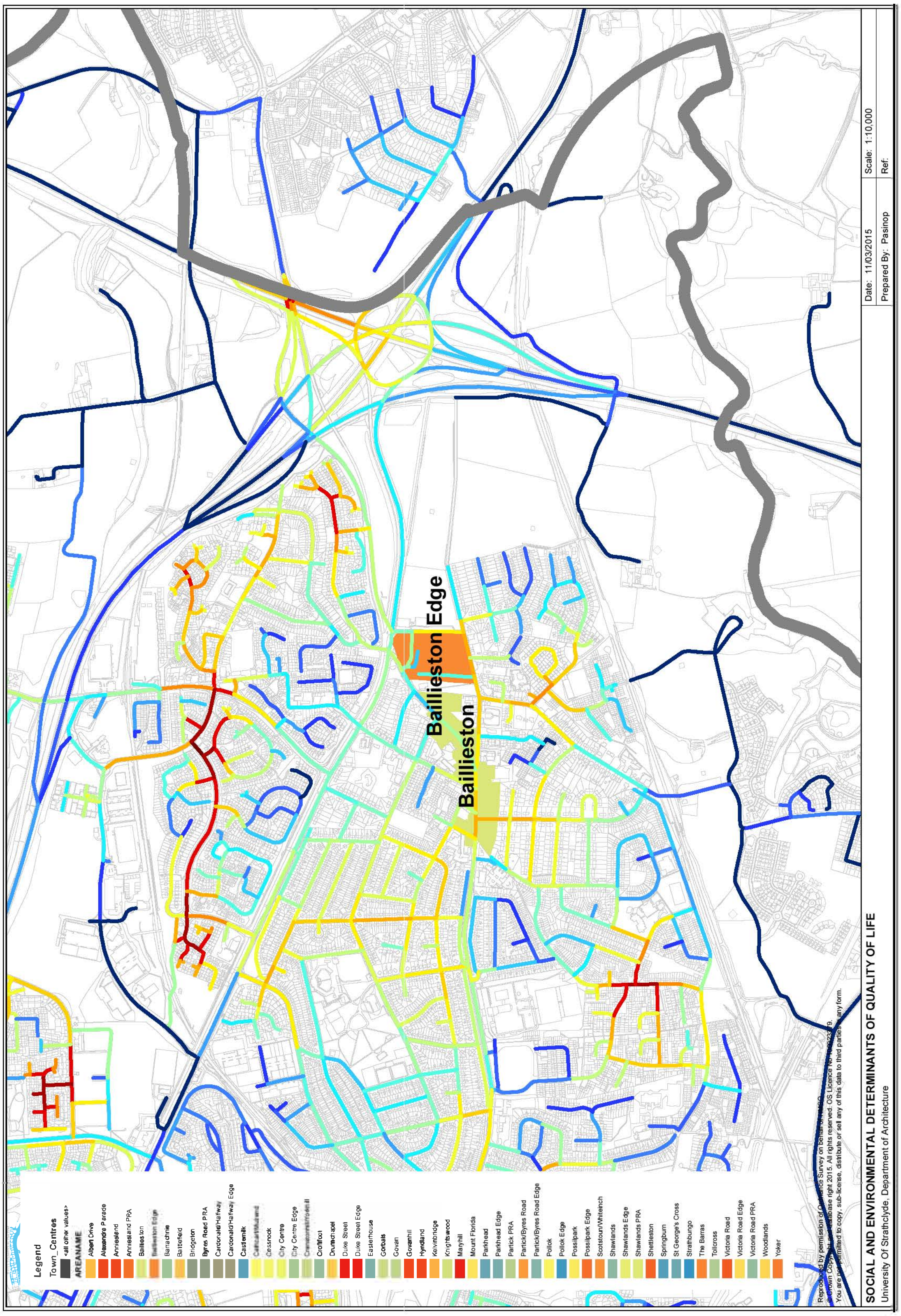


Figure 248. Closeness @400 Centrality Index. Town Centre: Baillieston Edge.pdf

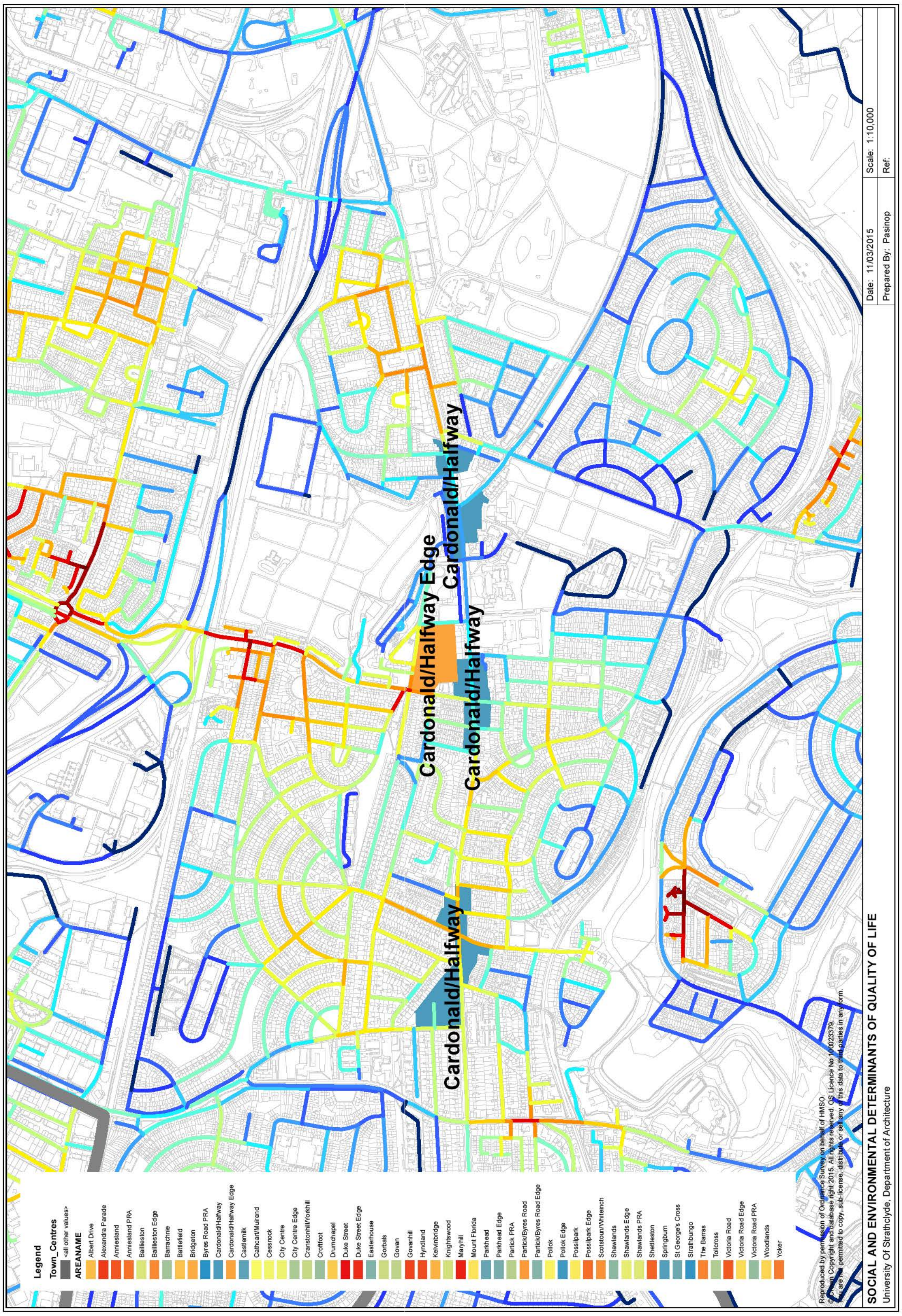


Figure 249. Closeness @400 Centrality Index. Town Centre: Cardonald_Halfway Edge.pdf

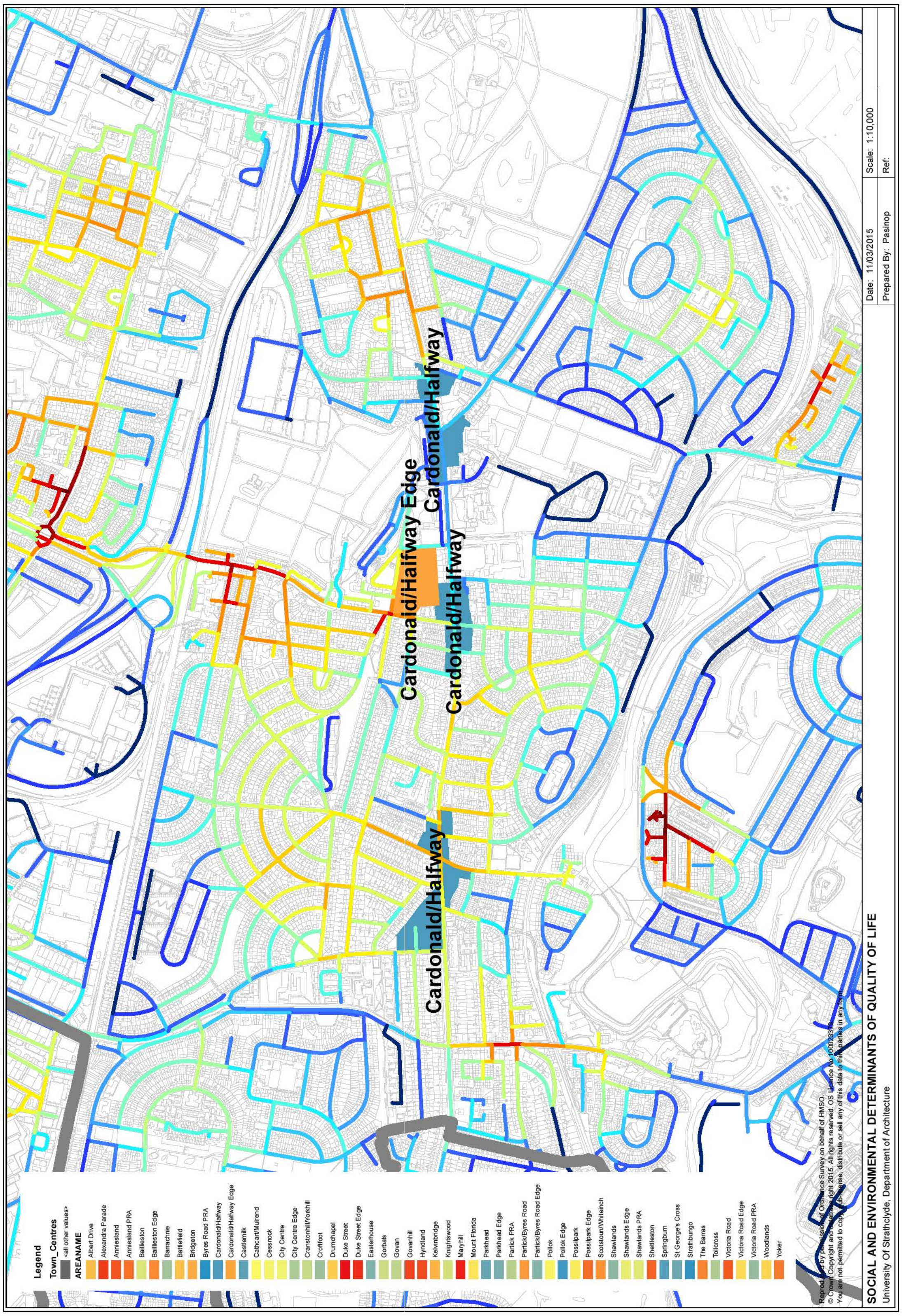


Figure 250. Closeness @400 Centrality Index. Town Centre: Cardonald_Halfway.pdf

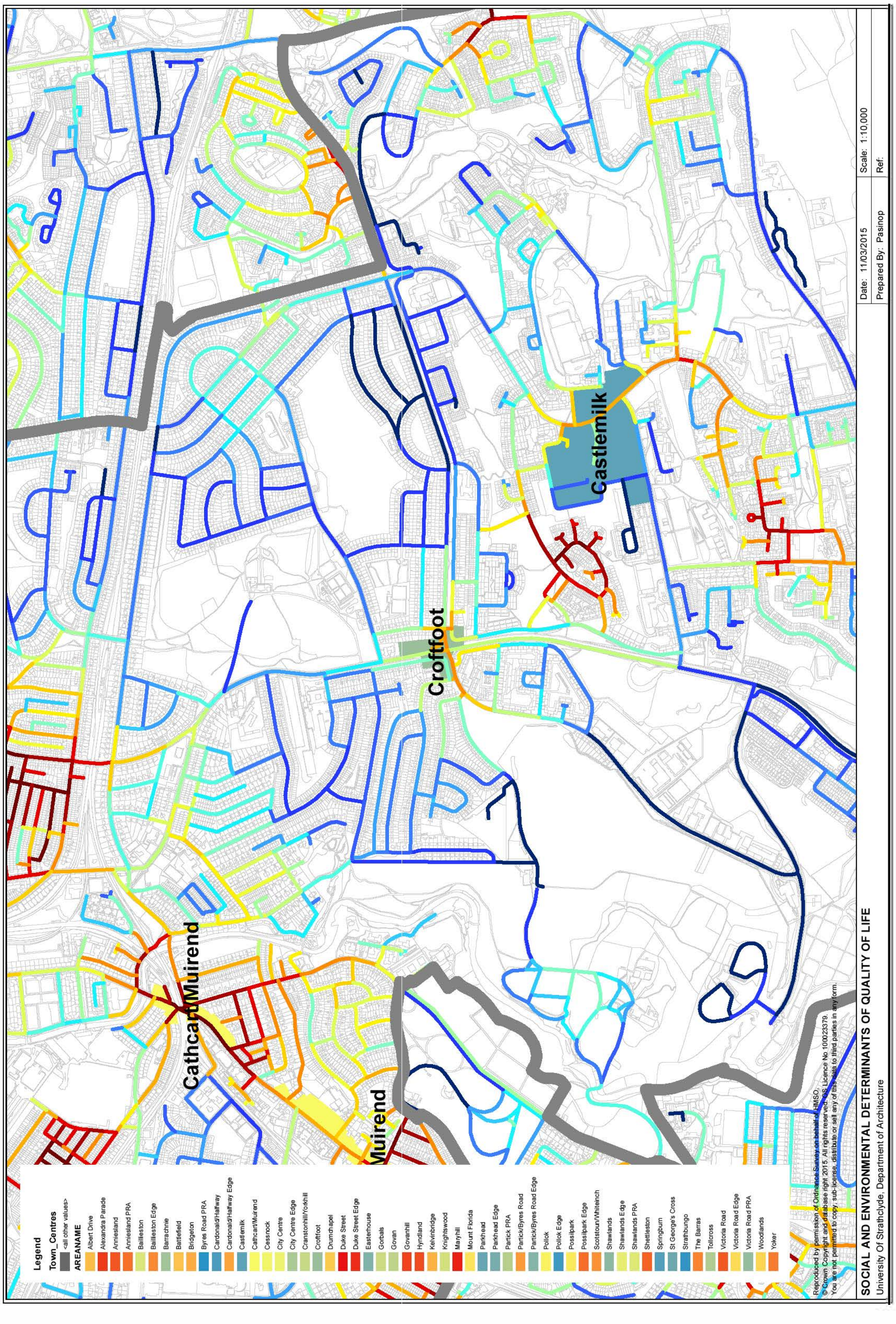


Figure 251. *Closeness @400 Centrality Index. Town Centre: Croftfoot.pdf*

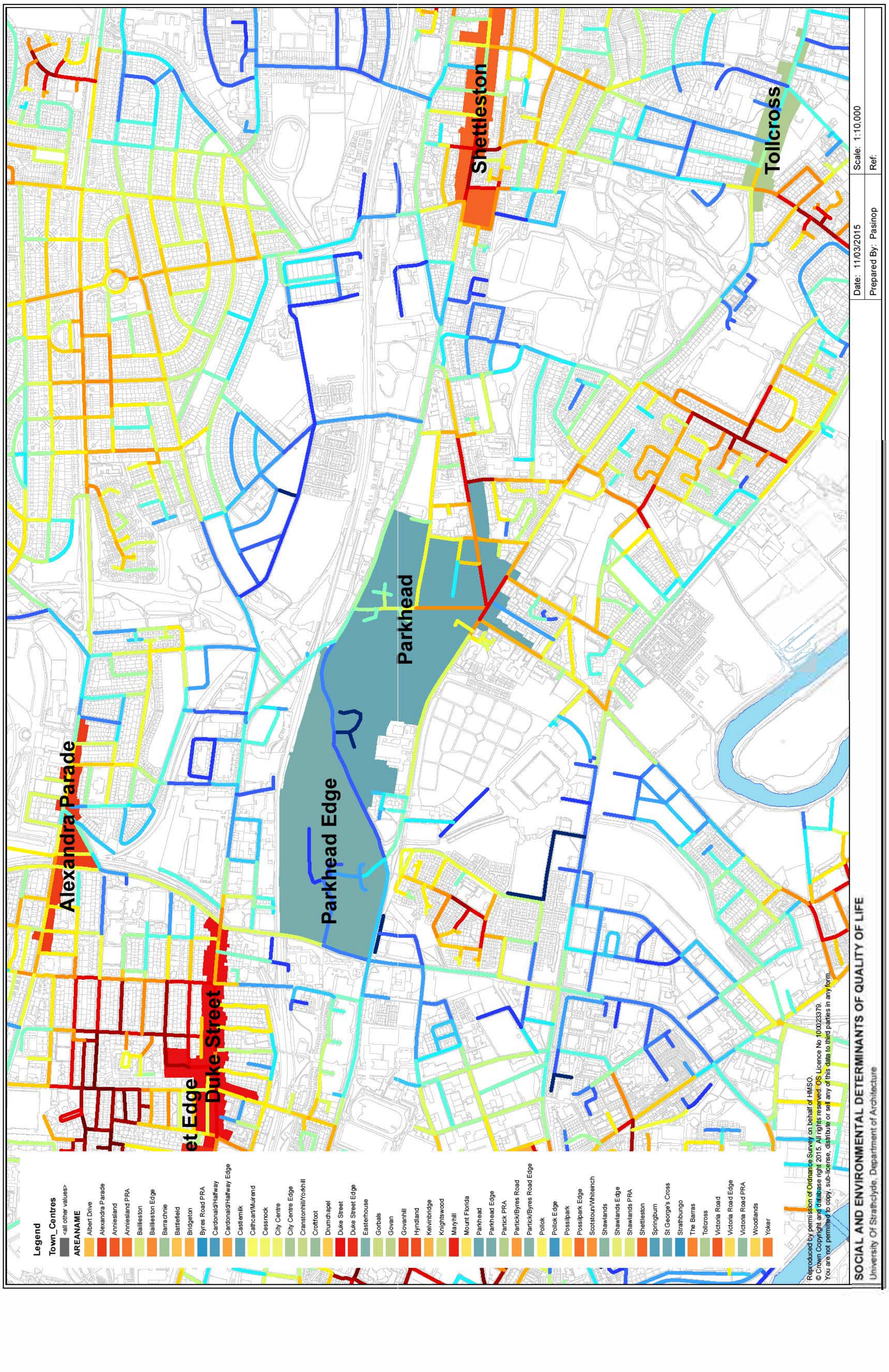


Figure 252. Closeness @400 Centrality Index. Town Centre: Parkhead.pdf

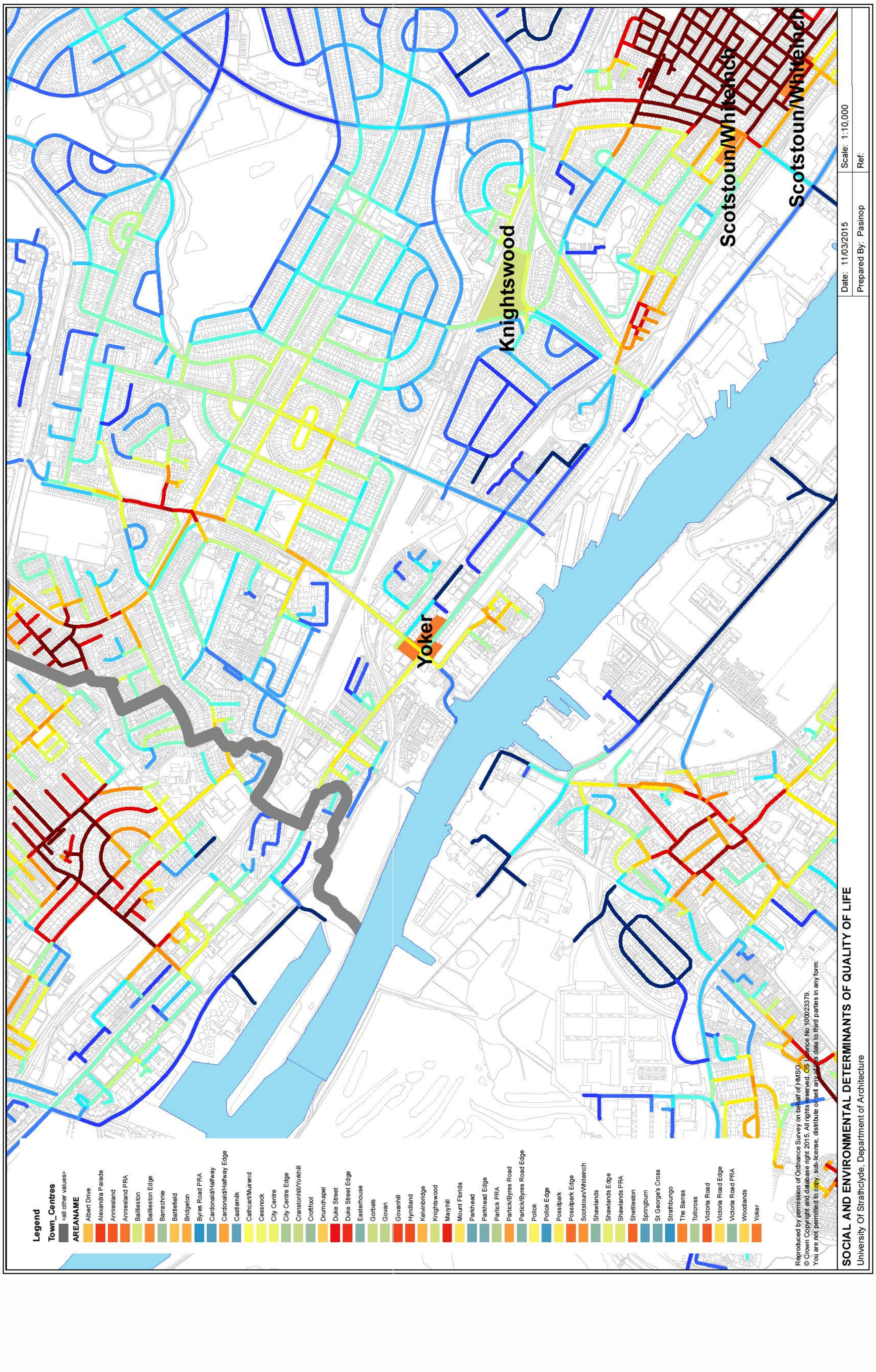


Figure 253. Closeness @400 Centrality Index. Town Centre: Yoker.pdf

8.5. Appendix 3: Previously published work

8.5.1. Multiple centrality assessment: understanding and designing mixed use streets in professional masterplanning.

125 **URBAN DESIGN**

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MIXED STREETS

MULTIPLE CENTRALITY ASSESSMENT

Sergio Porta and his colleagues apply a computer based methodology to mixed use streets

↑ Street betweenness centrality in three cities (red=high, blue=low)

Non-residential economic activities are the heart of mixed use streets. That makes mixed use streets extremely difficult to plan and develop as the activities they support require certain conditions to flourish. Those conditions, in turn, depend on spatial as well as non-spatial drivers, and equally they depend on each other. Like the emergence and evolution of living organisms, that of mixed use streets goes through an infinite succession of individual and collective initiatives, the vast majority of which are destined to fail due to adverse environmental conditions. Managing such conditions is the only chance that designers have to influence the development and evolution of mixed streets in their plans.

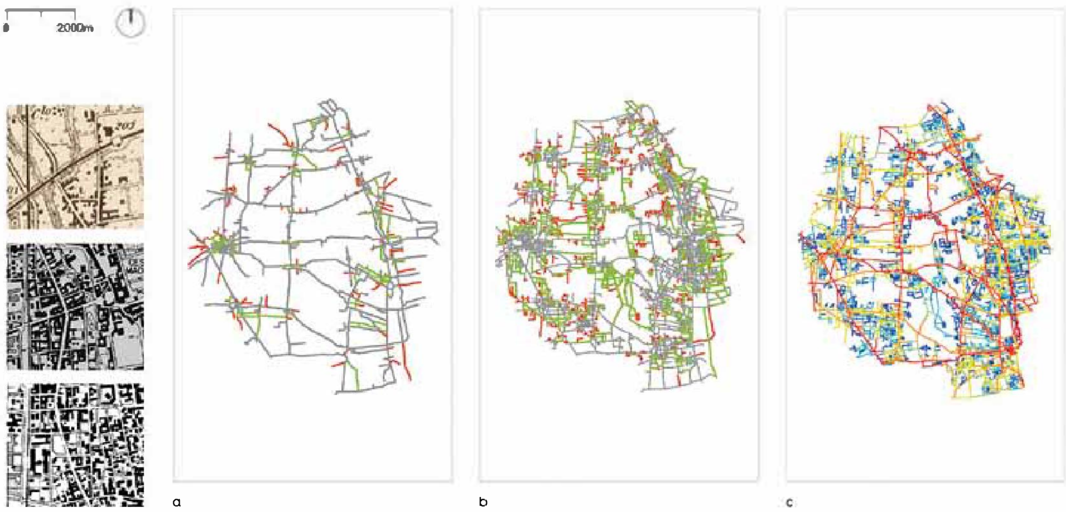
One of the most profound spatial determinants of non-residential uses in cities is street centrality. Multiple Centrality Assessment (MCA) is a computer-operated procedure for mapping the centrality of urban streets and spaces. It applies to spatial cases a set of methods drawn from research into the physics of complex networks in nature, society, culture and technology which emerged in the late 1950s and have gained momentum since the 1990s. Centrality is a critical element of the structure of all complex networks; its importance in spatial networks has been widely acknowledged in geography, transportation planning and regional analysis, as linked to a notion of proximity. In urban design, since the mid 1980s, Space Syntax has developed a wider understanding of centrality in urban systems. The MCA has re-interpreted these as a special class of complex networks. In both, centrality goes beyond proximity, dealing with how people experience and navigate the system of streets and intersections. The importance of street centrality for urban designers and planners is twofold: it influences collective behavior – impacting on key-dynamics such as real estate values, land use and crime; it is a primal factor in development and evolution of city form over time.

THE MCA ANALYSIS OF CITIES

In the MCA of street patterns we developed evidence-based knowledge at the interface between form and use of the public realm in three main areas: the structure and evolution in time of street networks; the correlation between street centrality and location of economic activities; and the structure of space – either external (not necessarily streets) or internal to buildings.

We first applied MCA at city scale to comparative studies of dozens of cities highlighting and distinguishing non-planned from planned street patterns, up to a classification of cities, and identifying common universal patterns as well as specificities of the urban form.

We then looked at the evolution of street networks in time, by analysing the process of urbanisation of a 125 km2 suburban area close to Milan, Italy over two centuries. We found a dynamic of spatial fragmentation that follows two distinct patterns, one of densification and one of expansion (exploration). Remarkably, the structure of very central streets tends to remain constant in the long term despite substantial economic, cultural,



technological and demographic change.

Also significant is the close correlation between centrality and the location of different categories of economic activities; correlation emerges in most different physical, cultural and economic contexts. Surprisingly, however, we found that in cities as different as Bologna, Barcelona and Glasgow, primary activities (eg. rare and specialist shops and services) tend to cluster around central streets, but secondary activities (eg. mainstream shops and services of daily use) require all the centrality they can get, and cluster around peaks of centrality even more than primary ones. MCA captures here a deep determinant of urban form, evolution and life.

MCA IN PROFESSIONAL MASTERPLANNING

With most significant masterplanning projects, unless they are in existing city centres, the majority of uses are residential. The commercial rule-of-thumb ratio of retail demand to residential numbers is surprisingly high at between 660:1 and 1,000:1 units. Furthermore, as developments progress at sales rates of 2.5 to 3 units per month, the time taken to create this critical mass can be considerable. Experience has shown that well-located small commercial units, clustered and associated with housing, can contradict negative market predictions based on a simple assessment of supply, without reference to context. Recent investigation into residential sales potential has also shown that sale by location would ideally include proximity to local shops. This indicates that there might be financial justification for subsidising retail outlets at early stages of development in order to create active streets. Mixed use and active streets can, therefore, contradict conventional market assessments, and confirm the widely observed benefits of mixed use and active streets in creating a sense of place and an attachment to that place, the symbiotic relationship between these uses and the social advantages of locally shared facilities.

If the advantages are to have credibility and if the allocated uses are to survive, the location of the uses has to be effective. Centrality and the best location for street activity are often relatively clear but it can be hard to persuade land-holders or regulatory authorities concentrating on immediate return or rigid regulation. With a scientific tool such as the MCA not only can the best location for active streets be more clearly identified and fine-tuned but can be demonstrated with clarity and effectiveness.

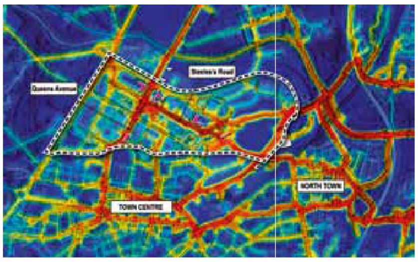
Recently ADAM Urbanism has partnered the Urban Design Studies Unit at University of Strathclyde under the EPSRC-Knowledge Transfer Account programme to study the capacity of MCA in professional urban design. As part of this experiment, MCA was applied to the masterplan of Aldershot, UK. The project is for a new mixed use residential development of around 3,800 homes. The 148 hectare site is surplus military land owned by Ministry of Defence. The scheme will provide community facilities, schools, local centres and leisure uses. The plan will include the restoration and conservation of several historic buildings, including the landmark Cambridge Military Hospital. The masterplan is structured on a strong network of well-connected streets and spaces linking the development to the wider area. In this approach, the hierarchy of streets, as nicely captured by MCA, plays an important role in sustaining a variety of uses. Queen's Avenue, the central North-South axis, is the main mixed use street within the masterplan: the neighbourhood centre, a hospital, two churches, a school, shops, offices and houses are facing this street. Another mixed use street is Steele's Road. It intersects Queen's Avenue in the main square of the new development where the neighbourhood centre is located and it is characterised by the presence of a school, offices and houses.

Mapping the density of betweenness centrality in Aldershot shows that the global connectivity of the area improves in a natural manner that

> There might be financial justification for subsidising retail outlets at early stages of development in order to create active streets

↑ Evolution of street network in the Groane area Milan
a) Grey: streets in 1833, green: new streets in 1914, red: new streets in 1914,
b) Grey: streets in 1980, green: new streets in 1994, red: new streets in 1994
c) Street betweenness centrality in 2007, red: high centrality, blue: low centrality

→ Aldershot: density of betweenness centrality in the proposed masterplan (dashed boundary), with location of mixed use buildings (purple) along main streets
↘ Aldershot, UK, image of the proposed development along a main street



adds potential to the social hub of the proposed development: the new neighbourhood is better connected with North Town through a West-to-East axis (Steele's Road) and the good connectivity of the North-South axis (Queen's Avenue) is kept the same. Moreover, it clearly highlights the importance of these streets as optimal locations for a mix of different functions as proposed in the masterplan: in this case, the MCA analysis confirmed and supported the design choices.

CONCLUSIONS

The MCA analysis of urban streets and spaces has demonstrated a high capacity to capture their potential to develop into mixed use urban environments. As such, it has been applied as a supporting tool on masterplans designed by ADAM Urbanism in several real professional cases. MCA confirmed and justified a series of design choices regarding the generation and character of mixed use streets and enabled the team to select the most desirable option from several alternatives.

Work continues on the research front at University of Strathclyde as well as on the professional front at ADAM Urbanism, looking at the best methods for presenting the MCA to prospective commercial and regulatory users. MCA's potential lies in how it combines with other more established types of analysis, and how to easily explain its benefits to commissioning bodies, without the recourse to technical language. Currently, presentation techniques are being tested on various client groups and the development of appropriate terminology and case studies is under way. ●

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Emanuele Strano, LASIG Laboratory, EPFL Lausanne, CH
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Robert Adam, ADAM Urbanism, Winchester, UK

COMPLETE STREETS: MORE THAN A NEW DESIGN

Barbara McCann suggests a new approach to street design

→ Typical incomplete street in the United States (Joan Hudson)

The Complete Streets movement has swept the US over the past few years, as more than 400 jurisdictions have adopted Complete Streets policies and many more have discussed the concept. Yet the true meaning of the term is often misunderstood, leading to an ultimately fruitless search for the ideal complete street. Those searching for the ideal project may miss the real transformative power of the Complete Streets movement.

In the US, the norm has long been the incomplete street. The US transportation industry was deeply influenced by the massive project of building the Interstate Highway system – a network of 47,000 miles of limited-access freeways that knitted the country together in the 1950s and 1960s. Solving the design and safety challenges in creating this system set an orientation that persists to this day in US transportation planning and design. The goal of transportation projects is usually assumed

8.5.2. Learning from Glasgow. Geo-Statistics for Urban Management Problems

Strano, Emanuele, Paola Pasino, Sergio Porta, and Ombretta Romice. "Learning from Glasgow. Geo-Statistics for Urban Management Problems." In Vulnerability, Risk and Complexity: Impacts of global Change on Human Habitats (IAPS 21 Conference, Abstracts of Presentations). IAPS. Leipzig, Germany: Helmholtz Centre for Environmental Research - UFZ, 2010.

The planning of resources and management in cities is a multilayered task requiring a complex interpretative basis and the capacity to predict economic, social, environmental changes over time. This paper presents an approach to urban analysis based on complex systems and geostatistic to address complex urban management problems by the Urban Design Studies Unit (University of Strathclyde, Glasgow). Glasgow is the largest city in Scotland currently experiencing a slow period of population and economic growth (the latter as consequence of the recent global economic downturn); even a generally very buoyant property market and construction sectors now lack both the will and capacity to undertake long term commitments. Still, there is a great need for substantial regeneration and rationalisation of resources to address disparities in choice and lifestyles, affordability and access to a better quality of life. Aims of this work are to study the spatial distribution of retails across the city in relation to access, density and availability of services, using a set of GIS based geo-statistical analysis. This analysis uses street centrality indices, the spatial distribution of retails and an in-depth field study. The analysis of urban centralities is based on MCA model (Multiple Centrality Assessment) that utilizes a standard primal format for the street network representation and a "complex system approach" to define centrality by a set of multiple peer indices (Porta et al,2006b). These centralities are computed not only in terms of being close to all others (Closeness Centrality), as in many traditional model, but also in terms of being the intermediary between others (Betweeness Centrality) and being accessible via a straight route to all others indices are (Straightness Centrality). (Porta et al, 2006, Wasserman S, 1994) The distribution of activities is done by a common spatial interpolation GIS tool, that is Kernel Density. Basically, the KDE uses the density within a range (window) of each observation to represent the value at the centre of the window. Within the window, the KDE weighs nearby objects more than distant objects, on the basis of a kernel Function. The in-depth study on hierarchical nodes is based on studies that have shown how Glasgow has an urban pattern whereby main routes and public transport nodes broadly overlap with urban densities, although significant areas remain disconnected by such channels. The implication of these distributions for future densification and resources rationalisation are fundamental. These three variables (centrality, retail activities density and spatial distribution) are then interpolated through a raster analysis approach. As a result, a linear correlation between them indicates the location of areas with long term economic potential, and of those with little economic strength when related to street centrality and mixed land use. The analysis of results shows the limits and potential of this geo-statistical approach in relation to urban strategic planning.

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10. List of figures

12. List of Tables

11. List of Tables