

**Cartographies of Heritage:
Mapping the Interpretation of Landscape**

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Abstract

This thesis critically assesses the capabilities of data visualisation as a medium for effectively presenting and communicating fuzzy data, exploring cartographic methods as an effective form of knowledge communication. It considers how data visualisation can be used to explore landscape themes, specifically by integrating Geographic Information Systems (GIS) to represent and analyse qualitative data for understanding cultural heritage landscapes. Using heritage as a key geographical theme, the thesis considers how individuals place ‘value’ onto locations by reviewing theories of landscape aesthetics as a way of conceptualising landscape recognition.

By utilising GIS, the thesis devises a mixed-methods approach to map interpretations and responses to heritage landscapes, developing techniques to enable the visualisation of landscape responses through forms of digital cartography. The methodology is designed to be completed in two separate stages. The first stage involves the collection of categorical and quantifiable data through identified research methods. The second stage requires utilising the empirical data collection to create data visualisation and subsequent maps as evidence of the possibility to deploy qualitative cartographies.

Consequently, this thesis shows that cartographic representations can interrogate the relationships between people and place using mixed methods through a qualitative GIS approach. Whether these are part of a series of ongoing innovations, as unique stand-alone maps or as complimentary and supplementary methods of visualisation, data representations can effectively communicate people's experiences with or interpretations of landscapes. Data graphics and cartographic representations can be used alongside or in tandem to one another as part of the same visualisation, to create new innovative forms of data visualisation for interrogating and deciphering the complexities between people and place.

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Chapter 0.0 Glossary

0.1 Acronyms

CAQDAS- Computer Aided Qualitative Data Analysis Scheme

DCP- Data Collection Point

GIS- Geographic Information System

LC- Land Cover

LU- Land Use

OS- Ordnance Survey

0.2 Definitions

ArcMap- a piece of software used to display spatial data and explore various GIS datasets. It is used to edit, handle, manipulate and transform datasets into various formats, to design and create a variety of maps for either printing or publication.

Data Visualisation- being the process of representing and presenting data in various visual forms, to facilitate more insightful understandings of datasets and contribute towards the generation of new knowledge. It concerns all aspects and processes required to generate data representations, such as the collection and categorisation of information, the manipulation and transformation of data, and the application of representational attributes to symbolise groups and classifications of corresponding datasets. Methods are primarily exploratory tools for visualising data, though they can serve an investigatory purpose; prompting investigations and lines of enquiry.

Chapter 1.0 Introduction

1.1 Setting the Scene...

Data visualisation has become an increasingly popular and powerful tool for researchers who need to make sense of big data and analyse vast quantities of information (Shneiderman, 2014; Aparicio & Costa, 2014). Despite having existed for centuries, it has only received limited attention in recent academic work (Yau, 2013; Li, 2018). There are arguments that suggest data visualisation is primarily situated within quantitative research, with an aim to present numerical information in more revealing ways and formulate research hypotheses (Ware, 2004). Others have suggested that data visualisation has the potential to present emotions, meanings, and opinions, helping researchers to acquire more meaningful understandings of social phenomenon (Verdinelli & Scagnoli, 2013). Some argue for its use as an analytical tool in research (Li, 2018), where others suggest it is a creative practice for presenting data in more expressive, artistic forms. For others still, it is about distinguishing the purpose of the data representation, as either a communication tool through simple and effective formats, or as a form of exploratory data analysis to discover more (Yau, 2013; Kirk, 2016).

However, there is very little literature which helps social scientists to consider interrogating complex, primarily qualitative data through visualisation and data representation. Of course, researchers have for decades used various statistical programs to analyse census data and demographic characteristics of a population (i.e., gender, age, income, and so on), but it is less well-known to do so with people's emotions and perceptions. Specifically, spatial analysis allows for the visualisation of patterns that present information about human behaviours across defined geographical scales, most commonly through Geographic Information System (GIS) (Anselin, *et al.* 2010; Bivan, 2010). To do the same with qualitative data would deepen understandings of social processes within identified geographic areas and acquire further information about the relationships between people and place (Rucks-Ahidiana & Bierbaum, 2017). It would enable social scientists to engage with other analytical approaches and consider how lines of spatial enquiry may contribute to their research projects, fuelling the creation of new geographical knowledges.

The focus of this thesis is to consider how data visualisation can be used to explore landscape, specifically by integrating GIS to represent and analyse qualitative data for understanding cultural heritage landscapes. Using heritage as a key geographical theme, the purpose is to

provide better access to additional exploratory resources and consider more creative applications of digital visualisation as an opportunity to analyse (Windhager, *et al.* 2015; Shabani, *et al.* 2018). Digital access enables researchers to consolidate databases tailored to individual historical research projects and visualise material either for further academic use or general viewing (Chias and Abad, 2008). Other researchers have engaged with heritage through literal uses of computational programmes in architectural and landscape research, including modelling, data visualisation, and animation, to assist in the preservation and conservation of historical importance and cultural significance (Ioannides, *et al.* 2009). Few have considered the use of visualisation in exploring landscape experience and considered visualising the more intangible attributes relating to environments. This thesis is also interested in visual methodologies, methods, and modes of analysis. Through data manipulation and content analysis, researchers can decipher intangible data relating to cultural heritage from various medias (i.e., photos, films, and other visual records) (Murín, 2014). It allows academics to conceptualise links between identity, landscape and heritage, and the representational qualities of the landscape to support the intangible (i.e., evoke memory, sense of inheritance, and feeling) (Robertson and Webster, 2017). There are examples¹ of heritage and corresponding cultural heritage sites presented in cartographic form within this thesis, designed and tailored for a specific purpose. Yu, *et al.* (2016) use GIS to conduct spatial analyses and create land use maps. Their purpose is to systematically analyse the distribution of identified cultural heritage sites against various processes, including urbanisation, land use changes, deforestation, and other natural, environmental hazards (Yu, *et al.* 2016). Notably, whilst there are examples of how to visualise heritage, there is little regarding the representation of perception, relating to specific cultural heritage sites.

Heritage geographies and landscape research have been used to frame this research investigation, to examine the relationships between people and place. It is an empirically viable focus for this research, as historic landscapes encompass the significance of place based on historical and cultural contexts, whilst also associating cultural significance through the physical representations of society and their beliefs (Yang, *et al.* 2016; Braaksma, *et al.* 2016). Heritage is therefore a key theme that has guided the formation and implementation of the research methodology presented in this thesis, designed to integrate, and combine the quantitative and the qualitative. Specifically, using the developed tools and techniques to record evidence of themes and concepts, the thesis subsequently begins to make sense of

¹ Some of which are referred to throughout this thesis.

place, being the distinctiveness of identified landscapes and their role in contributing towards experience, perception, and interpretation. The production of data visualisation within this thesis allow researchers to visualise the relationships between people and place, enabling users to visually interrogate these connections and relationships regarding their spatial context and environment, and identify further evidence of external factors and influences (i.e., site layouts, accessibility, size, and scale).

With landscape as a recognised representation of cultural beliefs and societal processes and with cartography at forefront, I consider how these interpretations can be mapped for further spatial analysis and visual interrogation, to contribute towards a critical engagement between qualitative research and GIS. Overall, the thesis will argue that qualitative data can be presented through forms of data visualisation, offering evidence that social scientists can use these methods to see through the complexity of their datasets. I propose that by doing so through an integrative mixed methodology, it is possible to deepen and acquire more meaningful understandings of the relationships between people and place, derived from the exploratory, supplementary, and investigatory qualities of cartographic representation.

1.2 Research Aim

The overall aim of this research is to critically assess the capabilities of data visualisation as a medium for effectively presenting and communicating fuzzy data, exploring cartographic methods as an effective form of knowledge communication. More specifically, this research will develop more qualitative forms of cartography and investigate the power of mapping strategies to effectively communicate the relationships and connections between people and place at cultural heritage sites.

This thesis claims that cartography can be used as part of a data visualisation package to interrogate the relationships between people and place. Whether these are part of a series of ongoing innovations, as stand-alone maps, and/or as complimentary, supplementary methods of visualisation, data representations can effectively communicate individuals' experiences, perceptions, and responses to landscape.

1.2.1 Research Questions

To guide the thesis, the research will answer the following research questions to achieve the outlined aim above.

1. What strategies and techniques can be deployed to integrate the quantitative and qualitative, to create more qualitative forms of cartography that reveal the connections and complexities between people and heritage sites?
2. How can data visualisation and cartographic methods be innovated and adapted for heritage research, to represent the subjective and intangible factors and provide a form of knowledge communication?

The remainder of this chapter will identify and provide an overview of the three themes running through this thesis. These will be explored in-depth in Chapter 2.0, as part of the conceptual background. The introduction will then provide a chapter-by-chapter breakdown of the thesis.

1.3 Key Research Themes

1.3.1 Mapping and GIS

Mapping is the first key theme of the thesis, stemming from an association to GIS. Geographic information systems, or GIS, is the integration of technological processes and management tools designed to investigate and potentially solve problems relating to geospatial information (Chen, 2010). More specifically, GIS implements not only the processing of records for analysis, but the initial procuring of relevant information, how it is stored and then digitised through various software applications (Chen, 2010; Thornton, *et al.* 2011). It offers researchers opportunities to integrate and corroborate a variety of data types and datasets, from both primary and secondary data sources, through a single framework (Thornton, *et al.* 2011). With a focus on cartography at the forefront of this thesis, the investigation will address criticisms of GIS that emerged within human geography and highlight the importance of visualisation through GIS. It explores a variety of spatial representations and consider cartographic forms as a key technique for visualising qualitative data. GIS therefore provides the computational power to combine a variety of data types, and the exploratory resource to visualise and communicate social, geographical knowledge.

1.3.2 Data Visualisation

Visualising data is the second theme concerned with the representation and presentation of information, specifically how best to design and create effective visualisations to communicate findings from within datasets. Visualising information encompasses both the need and motivation to find out more about social, geographical phenomenon. It is a method of visual analysis that requires individuals to interpret data in more graphic forms, using

‘visual thinking’ to provide responses and feedback to various forms of data representation and communication (Dorling, 2012:4). Data visualisation in this thesis refers to both data graphics and cartographic representation, whereby visual representations as more than a flat piece of paper, computational product, or image. They are an artefact that can incorporate both meaning and direction, as well as function as a form for communicating knowledge (Delano-Smith & Kain, 2009). Data visualisation is not only a tool for representation and communication, but also a method and medium for revealing more about collated datasets. Individuals and researchers alike can look beyond the numbers to uncover the meanings and details about a snapshot of real life (Yau, 2011). The thesis proposes that data representations have a story-telling capability for presenting quantitative and qualitative data narratives, for social scientists to make better sense of data.

1.3.3 Landscape

Landscape or landscapes is the third theme, regarding its tripartite conceptualisation as a physical object that encompasses both humanistic and cultural themes (i.e., identity), the application of subjective detail relating to the interpretations, descriptions and meanings that individuals associate to specific landscapes, and a form of representation where landscape has a role in influencing responses and perceptions towards areas deemed historically importance and culturally significance. Landscape can represent meanings associated uniquely to the observer, governed by an individual’s milieu, social factors, interests, and motivations, and are often distorted by misconceptions, expectations, bias, and personal aims (Solymosi, 2011). It is a collective process of establishing an idea and/or opinion of an area, whether familiar to the individual or not. Specifically, landscape perception is the ability to explore the world and communicate the mental connections linking a person to the place they are situated within (Konkoly-Gyró, 2018). Emphasis can often be placed on certain qualities or attributes, which in turn contribute to perception and are framed as responses to environment (Solymosi, 2011; Konkoly-Gyró, 2018), such as physical attributes like topography or landscape type, or more immaterial qualities like aesthetics, meanings, and emotions. In this case, environments have the power to influence perception, with resulting perceptions having the power to persuade behaviours and reactions to space (Lynch, 1960; Rossetti, *et al.* 2019).

The conceptual background in Chapter 2.0 will discuss landscape from the lens of experiencing heritage landscape and refer to cultural heritage landscapes specifically. As an object of observation, landscape acts as a point of reference for this thesis, whereby the tangible and intangible are applied to symbolic points, landmarks, and monuments, for

individuals to associate value and meaning. Cultural heritage landscapes specifically are recognised by the great historical value, cultural significance and societal appreciation that define areas of perceived importance. They are ideal as stimuli to discuss perception and understand individual's responses to landscape, based on the cultural markers and processes that society engrains both upon and within environments (Wylie, 2007; Vecco, 2010). Notably, the association of value to place and the behaviours that occur within cultural heritage landscapes can each be investigated, to understand responses derived from historical and cultural contexts, aesthetic qualities and contributing symbolism. It considers how the physical environment may persuade perception and contribute to concepts including sense of place and identity (Ewing & Handy, 2009; Harvey-Aultman-Hall, 2016). The thesis will therefore examine the representational qualities of landscape and consider a mixed methodology designed to record and collect landscape interpretations.

1.4 Thesis Structure

In Chapter 2.0 I first approach GIS and outline a definition that underpins its conceptualisation of having more than just a quantitative association and encompassing a more integrative and effective role in geographic enquiry (Longley, *et al.* 2005; Boschmann & Cubbon, 2014). I address the criticisms regarding the inadequacy and technological capabilities associated to GIS and situate its role as part of an advantageous, integrative approach. Referred to as qualitative GIS, Elwood & Cope (2009) provide a framework to facilitate the development of more qualitative forms of cartography. In doing so, I highlight the importance of visualisation through GIS whereby qualitative GIS can apply various strengths and attributes from a quantitative context, providing an opportunity to present information and enable user interpretation. I present a brief history of mapping and cartography to signpost key developments in relation to the context of this research. Demonstrating a critical awareness, I explore the power of data visualisation to communicate information and tell the underlying stories from within data, by untangling the complexities within large datasets and presenting data in more appealing ways (Jiang & Li, 2005; Segel & Heer, 2010; Yau, 2011). Grounded visualisation has been chosen to underpin this thesis as it goes beyond the act of representation and presentation and considers the implication of a spatial quality to observe the relationships between people and place (Franke, *et al.* 2017). Finally, I engage with Wylie's (2007) conceptualisation of landscape. I propose that landscape is made up of a series of metaphorical layers that create a subjective veil of meaning, emotion, and description, and it is this veil that I investigate for perceptions relating to identified landscape themes. Landscape is therefore a tension that has the capability to present knowledge and persuade

perception, based on the encompassed tangible and intangible qualities of the environment (Wylie, 2007).

In Chapter 3.0 I present my mixed methodological approach to the research and outline how I have used GIS as a key integrative tool to devise new strategies and techniques for recording qualitative data (Aitken & Kwan, 2010). The focus is to develop cartographic representations that can communicate relationships and humanistic responses to landscape, by developing new techniques that can associate a spatial quality to collated qualitative datasets. I identify each of the data collection methods that have facilitated this quantification of qualitative information and highlight the need to provide a count or numerical measure to enable digitisation and manipulation. After justifying each of my three research locations, I argue that to seamlessly associate spatial quality to datasets there is growing need for researchers to implement a collection strategy, to provide specific geographical references that will allow researchers to link datasets to points in place (Schlossberg, *et al.* 2007). This process facilitates the analytical processes that have subsequently enabled for the spatialisation of data, to observe various social phenomena across identified places and contribute towards the production new geographical knowledges (Elwood & Cope, 2009; Aitken & Kwan, 2010).

Chapter 4.0 is the first empirical chapter that engages with the concept of storytelling with data. I introduce the first genre of representation, ‘Categorical Mapping’ to explore methods for collecting qualitative data and implement a technique for quantifying qualitative information. I develop these notations further by discussing spatial representations of categorical information and consider the supplementary power of land uses maps regarding their capability to provide environmental context to understand spatial phenomena. Specifically, through GIS, it is possible to overlay information on top of the land use and land cover maps and investigate what other factors may persuade the perceived social phenomenon (Cihlar & Jansen, 2001). I critically assess audit surveys as a method for ‘measuring’ qualitative data and quantifying records into suitable categories for computational processing, contributing a rubric to do so across different landscapes. Their role is to provide a measure of people’s interpretations associated to landscape perception and record the physical features within landscape that may contribute and persuade these responses (Ewing & Handy, 2009; Harvey & Aultman-Hall, 2016). Doing so facilitates the creation of ‘audit maps’, designed to be used as supplementary representations for exploring the complex relationships between and place.

Chapter 5.0 explores more familiar examples of cartographic representation and investigates the creation of two types of map designed to showcase the relationship between people and place through specific formatting and associated symbology; these are choropleth and flow maps. These maps manipulate the spatial quality from datasets whereby I critique the formulation of each and how I have adapted these forms of visualisation to present qualitative data in relation to specific spatial references. From the cultural heritage lens, their motive is to enable users to visualise and describe the patterns and distributions between categories of data, such as landscape perception themes in situ to spatial context, to tease out potential meanings and relationships between people and place (Robinson, *et al.* 1995; Phan, *et al.* 2005; Krygier & Wood, 2011). The chapter provides evidence that adds to existing bodies of research to suggest that qualitative data can be plotted cartographically. By mapping people's experiences of cultural heritage sites, the concentrations and distributions of phenomena can be interrogated in situ to spatial context. It allows researchers to communicate and decipher the complex relationships between people and place, to better respond to the how and why enquiries of research investigations.

The final empirical chapter, Chapter 6.0 investigates more creative forms of data representation that utilise a spatial attribute in different ways and to various degrees (Knowles, *et al.* 2015). I present three different forms of visualisation that communicate qualitative data in more creative, visually pleasing ways, combining data graphics with cartographic representations to visualise the relationships between people and place. I consider these as additional tools for mapping perception and exploring people's interpretations of cultural heritage landscapes. Acknowledging Yau's (2011) conceptualisation, visualisation can also be a medium for exploring datasets and uncovering the hidden meanings from within the narrative. I reinforce that as these visualisations are a more creative, experimental exploration of data representation and can only serve as supplementary and exploratory forms of visualisation. They can however provide further context and supply additional geographical knowledges, as part of an integrative approach to research.

Finally, Chapter 7.0 will critically review the conceptualisations, applied frameworks and key empirical findings to provide an overall conclusion. It will summarise the core contributions made by the thesis and outlines how the key findings could indicate further future areas of research.

Chapter 2.0 Mapping, Data, and Interpretation: Towards a Conceptual Background

2.1 Aim and Purpose

Understanding data remains a challenge for all those who grapple with and aim to decipher its content, meanings, and results. As technological advancements have rapidly increased, this challenge has neither dwindled nor diminished whilst data production has too increased creating subsequent big datasets (Cheshire & Batty, 2012). One key issue now is to figure out how best to handle, analyse and make sense of large quantities of complex data. Data visualisation offers an alternative method of analysis to provide not only the description to uncover the what, where and when, but also consider the how and why contexts across a variety of scales (i.e., temporal and spatial, micro and macro) (Cheshire & Batty, 2012). Whilst this thesis may handle much smaller datasets unlike those referred to by Cheshire and Batty (2012), I argue that through empirical analysis and an awareness of methodology design, maps as a form of representation can communicate information and subsequent knowledges by considering integrative approaches and incorporating key technologies and analytical techniques. The underlying motive to use GIS to map qualitative data and better understand spatial, social phenomena, relies on the technological capabilities of the system, and the integration of multiple knowledges through a mixed methods approach, to produce representations that present the emerging stories from within complex datasets. Subsequently, data visualisation can incorporate both data graphics and cartographic representations as part of a visualising package, enabling researchers to question data through visual techniques and decode the narrative and/or findings through interpretation.

The first section introduces GIS by pinpointing a definition that will be used throughout this thesis. It explores the conceptualisation of the term leading towards discussions of GIS and its fluctuating role within the social sciences (Lin, 2012; Boschmann & Cubbon, 2014). The section addresses criticisms of GIS that emerged within human geography, questioning its inadequacy and capability as a technological resource, recognising the power issues through representation and the binary between quantitative and qualitative research (Kwan, 2002a; O'Sullivan, 2006; Yeager & Steiger, 2013). I acknowledge qualitative GIS as a beneficial, reflexive, and integrative approach to research, considering Cope & Elwood's (2009) three-layered framework as key to developing more qualitative forms of cartography. In doing so, I highlight the importance of visualisation through GIS whereby qualitative GIS can apply

various strengths and attributes from a quantitative context, providing an opportunity to present information and enable user interpretation.

The second section, *Visualising Data*, starts with a brief history of mapping and cartography to signpost key developments in relation to the context of this research. It observes the power of representational methods to communicate information and tell the underlying stories from within data, by untangling the complexities within large datasets and presenting data in more appealing ways (Jiang & Li, 2005; Segel & Heer, 2010; Yau, 2011). It acknowledges the transition of cartography into a more digital world (Kraak, 2003), and what this has meant in terms of mapping and emerging critical discussions. In this review, data visualisation considers both cartographic representations and data graphics as part of a visualisation package, enabling users to make sense of data through associated tools and techniques (Yau, 2011; Lee, *et al.* 2015; Kirk, 2016). I acknowledge the various rules and design principles required to do so effectively, regarding the communication of knowledge through cartographic strategies, including an understanding of visual perception and cognition, and the use of colour and map symbols to convey a clear message (Griffin, 2017).

Grounded visualisation was chosen to underpin the thesis in relation to the story-telling quality of data visualisation and its use as an integrative approach for exploring and analysing spatial data and qualitative datasets (Knigge & Cope, 2006; Elwood & Cope, 2009). Alongside qualitative GIS, this approach can facilitate the integration of various data types, multiple forms of analysis and representation techniques, using GIS to observe the relationship between people and place through newly emerging lines of enquiry (Elwood & Cope, 2009; Seegers & Giordano, 2015; Franke, *et al.* 2017). Combining grounded theory and visualisation, the qualities of grounded visualisation, being exploratory powers, iterative and recursive processes, the particular and the general, and representations of multiple interpretations (Knigge & Cope, 2006, 2009), all facilitate the designing of new maps capable of presenting qualitative data and exploring perceptions in relation to identified locations and environments. Subsequently, the conversation turns to examine the power of mapping and offers a critical awareness of GIS, cartographic practice, and the emerging capabilities to ‘blur’ the lines between mapping and qualitative research, observing those who ‘break the rules’ through more innovative approaches to cartography and data visualisation.

The third section introduces landscape as a problematic term and draws upon the work of Carl Sauer (1889-1975), William George Hoskins (1908-1992), and John Brinckerhoff Jackson

(1909-1996), to place my research in line with a definition suitable for this thesis (Wylie, 2007; Gregory, *et al.* 2009). Specifically, landscape is not only a physical object or thing that is subject to interpretation, but also a process that may persuade perception and response (Wylie, 2007). I explore Wylie's (2007) tripartite conceptualisation to argue that landscape is both a text and an image, made up of various symbols that reinforce its quality as a form of representation based on society's responses to various environments (Appleton, 1996; Belletani, 2016). It consists of a series of metaphorical layers placed upon identified spaces through landscape perception, that together create a veil of subjective detail that enables researchers to look for evidence of themes and concepts (Stobbelaar & Pedroli, 2011; Soini, *et al.* 2012). Through a critical engagement, I recognise sense of place as a multifaceted concept and identify five corresponding components suitable for examining landscape interpretation (Shamsuddin & Ujang, 2008; Vecco, 2010; Soini, *et al.* 2012; Yang, *et al.* 2016). This provides me with an initial framework to consider how to record evidence of landscape interpretation, to underpin the thesis methodology. Finally, I will investigate the representational qualities of landscape as a form of tension, whereby landscape can both present various forms of knowledge as a material object, but it can also persuade the perceptions of society through engrained qualities and attributes (Wylie, 2007).

2.2 Geographic Information Systems

As Sui and Morrill (2004:82) rightly state, 'no other technological innovation in human history has affected the practice of geography in such a profound way as the computer.' Digital devices, software packages and associated modes of data generation, processing, storage, analysis and so on, have become dependent on computational technologies (Ash, *et al.* 2018), with technology becoming a common, more standard media of knowledge generation and analysis. It is becoming ever more popular to use key techniques to visualise data, including mapping and geovisualisation techniques for revealing spatial patterns and processes (Travis, 2015).

Specifically, geovisualisation refers to the visualisation of geospatial information created by integrating information from a variety of sources. GIS is the most used system for doing this, providing a capability to map, query, retrieve and analyse data from a corresponding database (Jiang & Li, 2005). It has four principal purposes through which to conduct spatial queries, being visual exploration, synthesis, analysis, and the presentation of geospatial data relating to various geographic phenomena (Kraak, 2003, 2005; Dykes, *et al.* 2005). Maps present a selection of a complex reality and visualise it in a more abstract way (Kraak, 2006). They

encourage visual thinking about geospatial patterns and trends, relying on an integrated approach from cartography with information representation and other forms of scientific visualisation, as well as image analysis, exploratory data analysis, visual analytics and GIScience² (Dykes, *et al.* 2005; Kraak, 2006). To create effective geovisualisation users therefore need the key components of a GIS, being the database, a digital map, a computer to link data to a spatial/geographical reference, and the intended audience/user to interpret the presented results. More specifically, researchers can do so through software including ArcMap, QGIS, ArcScene and various other available GIS packages.

GIS refers to the handling, analysis, and representations of spatial data (Chen, 2010), and is often used to describe a single system (Pickles, 1995). Supported by Pickles (1995, 1997), Chen (2010), and Thornton, *et al.* (2011), for this thesis I propose:

GIS is the association of a dataset, collected, stored, and managed through a series of computational process. It allows the user to assign specific geographical references to information and analyse this detail through software tools across a variety of geographical scales. The aim is to produce outputs relevant to individual research projects. It is the incorporation of; technology to facilitate various methodological and analytical capabilities and integrate data from a variety of sources; a research agenda that users follow to test and investigate spatial representations, data visualisation, and cartography; and finally, the community including how GIS is perceived and received by both academic and public audiences.

GIS is subsequently rooted in the study of spatial knowledge, location, and the representation of complex information, providing inarguable evidence of the relationship between GIS and geography (Longley, *et al.* 2005). As a line of enquiry, GIS can address and investigate human geographical concepts, like the scale of migration across various spatial scales, using GIS to measure, represent, produce, and transform information into various representations and communicators of knowledge (Chrisman, 2003; Longley, *et al.* 2005). However, Longley (2000) advises that researchers who are most familiar with the software and programming are the better equipped to use it and corresponding datasets. Whilst GIS may have supportive roles within research, it can restrict and alienate the discipline through specialised use, simply becoming a tool rather than an effective source of spatial analysis for multiple disciplines

² GIScience is explored in section 2.3.1 A Brief History of Mapping and Cartography, regarding digital cartography.

(Pickles, 1997; Longley, 2000; Elwood, 2005). On the other hand, GIS is not a ‘cookbook’ ideology of instructions that will lead the user to definite success within the research process (Campbell, 2005:621). Users should recognise the capabilities of GIS alongside its rootedness in the study of spatial knowledge and geographic enquiry.

Conventionally, GIS is recognised primarily as a quantitative concept, developing what is commonly referred to as ‘quantitative geography’ (Taylor & Johnston, 1995, cited in Longley, 2000:37). It consists of a variety of conceptualised approaches to spatial science, whether through various forms of statistical modelling and/or spatial analysis, that enable various fields of geography to investigate phenomena across space and time. However, GIS is not necessarily associated to just quantitative methods. The roles of GIS have begun to fluctuate and incorporate more humanistic and interpretative forms of data, becoming more common practise to use geospatial data as a groundwork to present and analyse more complex, more dynamic datasets (Lin, 2012). The underlying motive is to use GIS to map qualitative data and better understand spatial, social phenomena. For example, sketch maps can be used to collect accounts of individuals’ experiences, turning them into unique, spatial data records and enabling a visualisation of socio-spatial processes (Boschmann & Cubbon, 2014). Another example involves taking diary accounts or pieces of literature and extracting details to map individuals’ spatial experiences (Cooper & Gregory, 2011). Furthermore, the portrayal of qualitative context through visual representations requires developing quantitative methods associated to GIS, drawing upon newer concepts and approaches to form a qualitative GIS (Elwood, 2010).

Before I argue for a more qualitative form of GIS, it is necessary to discuss the emergent of critical GIS stemming from the 1990’s, specifically, the association of social theory and humanistic concepts through applications of GIS (Harvey, *et al.* 2005; Pavlovskaya, 2018).

2.2.1 Critical GIS

Critical GIS emerged from early criticisms of GIS within human geography, in attempts to understand the social implications of GIS regarding its cross-disciplinary nature for enquiry (Harvey, *et al.* 2005). Technologically, GIS can collect, integrate, and manage data but was often described as ‘inadequate’ for use and unable to facilitate meaningful analyses (Taylor, 1990 cited by Schuurman, 2000:572). Focussing more on the ‘facts’ rather than more meaningful analyses, GIS scholars in geography specifically highlighted issues with the content of maps and the treatment of databases, realising that databases and associated

processes can be inaccurate (Goodchild, 1991). Rather than this being negative conation, Goodchild (1991:336) highlighted the ‘fuzziness and generalization’ that emerges from cartography, stating that GIS is not a ‘mere tool’, but also a way of prompting further geographical thought and enquiry. However, researchers studying the relationship³ between GIS and society pointed out that GIS usage and representations were shaped by power relations (Schuurman, 2000). Critics of GIS were therefore suspicious of its use and ability to present the ‘truth’ (Law, 1994:7), with which scholars called for more attention to better understand the uses of GIS and its perceived meanings.

GIS access and usage by practitioners and non-academics are also factors considered under critical GIS, regarding the social, political, and epistemological implications of GIS. Through participatory GIS (PGIS), there have been efforts by GIS researchers and non-traditional users to make use of GIS and use it to meet their own spatial knowledges, priorities, and requirements (Elwood, 2006). However, whilst PGIS has attempted to intervene and diversify the creation of spatial knowledge, there are still ambiguities about how to make GIS more inclusive, how to adapt the technology to incorporate multimedia and develop new representational strategies, and use it to inform decision-making processes (i.e., urban environmental planning). As Elwood (2006) explains, ‘grassroot’ groups tend to use GIS to produce a cartographic spatial narrative, rather than to answer research questions, meaning the value of GIS changes from its spatial analytical capabilities to more experimental functions for spatial representations.

While there are these issues discussed in critical GIS, O’Sullivan (2006) argues that critical GIS does not have a research agenda, though it is often incorporated and applied within one. Specifically, feminist geography researchers critically reflect on the positionality of the user, the research process, and the creation of knowledge through GIS applications (Kwan, 2002a). Researchers, such as Taylor (1990, cited by Kwan, 2002a) and Dixon and Jones (1998, cited by Kwan, 2002a) argue that GIS is predominantly considered a tool for quantitative research and spatial analysis, to provide answers to specific sets of questions and empirical through the generalisation of information. They suggest that GIS can implement a dualism and/or a divide between the quantitative and qualitative. Any answers or conclusions derived from an analysis cannot be representative of subjective research (Dixon and Jones, 1998, cited by Kwan 2002a) and cannot be used to understand feelings, opinions, and other subjectivities. However, Kwan

³ See Harley (1992:233-238) regarding the selective representations of maps.

(2002a:653) argues that GIS can be re-envisioned and used within feminist research, by integrating ethnographies with GIS to present the ‘spatial stories’ about women’s lives. I too argue that considering GIS as only suitable for quantitative methods is limited and dissuades researchers from using GIS as part of a more integrative, reflexive practice.

Methodologically speaking, GIS can be used to interrogate social data and present more qualitative forms of information, including associated description and detail. As a specific tool, GIS can be used to represent various layers of information to visualise geographical phenomenon and spatial contexts, overlaying the data to reveal further relationships and patterns between variables (Kwan, 2002a; Yeager & Steiger, 2013). Its technological capabilities allow researchers to run GIS software alongside other qualitative-based software like NVIVO, integrating the resulting data and developing a more exploratory approach to research; more complex connections can be discovered from within datasets, enabling researchers to visualise information across a range of geographical scales. Whilst quantitative methods risk overgeneralising information and restrict ability to understand meaning, integrating qualitative research can reinstate a level of meaning and context, to create a more detailed picture of results (Yeager & Steiger, 2013). The technology has become more flexible and responsive to the needs of the researcher, enabling them to incorporate many different types of information and knowledges associated with various spatial ontologies (Pavlovskaya, 2018).

However, I wish to take these possibilities further and provide evidence to support this capability through the thesis project. Researchers can use qualitative data to create new forms of cartographic narrative by incorporating other data sources (for example, photographs, sketch maps, video clips and voice recordings) into spatial software. Though these data sources must be digitised into various computational formats, GIS can integrate these datasets and apply the spatial context for mapping, creating data representations that promote better engagement between individual datasets and facilitate enquiry. Methodologically, researchers must be selective over their collection techniques and subsequent collated datasets, to ensure the combination of methods can compensate for limitations and are applicable to the corresponding research questions (Kwan, 2002a). Underpinned by this body of work on critical GIS and in particular research addressing the possibilities of using GIS to incorporate qualitative data, it is necessary to discuss the field of qualitative GIS, which is presented in the next subsection.

2.2.2 Qualitative GIS

Qualitative GIS is a series of approaches that seek to,

‘integrate qualitative forms of data into GIS, develop and support qualitative approaches to building knowledge and explanation with GIS, use GIS in research that emerges from multiple or hybrid epistemologies, and theorize previously unrecognized forms of social knowledge that may be present in GIS applications’ (Elwood & Cope, 2009:4).

As explored earlier, GIS is a digital technology capable of storing, managing, analysing, and representing geographic information and is a series of practices for producing and discussing geographic knowledge through associated representations and various analyses of spatial data (Chrisman, 2002). Qualitative GIS, however, has a core purpose to integrate multiple knowledges and findings from a variety of techniques, implying a mixed methods approach. It differs from more conventional GIS practices because it ‘assumes that geographic phenomena, their relationships, and their meanings are produced and negotiated at many different moments in GIS development and application’ (Elwood & Cope, 2009:2). The ‘qualitative’ aspect does not merely encompass data that is simply non-numerical, rather it associates datasets that provide rich contextual detail, and the deeper meanings and provision of interpretations of the situations and processes that the data describes (Knowles, *et al.* 2015). It also includes analysis, such as grounded theory, whereby the intent is to draw out interpretative detail and uncover negotiated meanings and situated knowledges.

There are several intersections between GIS and qualitative research regarding the numerous approaches that aim to bring the two together, without treating qualitative methods as a form of ‘add-on’ (Elwood & Cope, 2009:4). The integrative qualities of methodologies, the framing of questions, the analysis, and data representations, can all be used in a more advantageous way, if researchers considered qualitative GIS as ‘an assemblage of hardware, software, data structures, and procedures for working with digital spatial data’, enabling users to conceptualise GIS as a method of knowledge production to acquire more in-depth understandings of topics through spatial analysis (Elwood and Cope, 2009:6). For example, Jung (2009) incorporates qualitative data and quantitative data analysis techniques by deploying methods that link GIS software to other forms of computer-aided qualitative data analysis software (CAQ-DAS). By georeferencing photographs, it is possible to use the qualitative codes from content analysis and analyse these through GIS, creating opportunities to investigate phenomena using exploratory visual methods. In this case, qualitative GIS researchers consider GIS as a ‘social and political practice’ and by using it alongside multiple forms of analysis and representation techniques, researchers can engage with numerous lines

of enquiry regarding the broader world (Elwood & Cope, 2009). Notably, these newer approaches to GIS are often critiqued and contested in response to the claimed difficulties of integrating qualitative with quantitative study.

Qualitative methodologies are well known for their in-depth and intensive approaches to research, rather than the collection and quantification of information and numerical strategy (Dwyer and Limb, 2001; Aitken & Kwan, 2010). Within human geographies, researchers are turning to focus more on understanding human experiences within various socio-spatial settings, their methodologies changing from less of an ethnographic foundation of observation, to more intense, more strategic uses of qualitative methods (Matthews, *et al.* 2005; Pavlovskaya, 2009a; Knigge & Cope, 2009; Knowles, *et al.* 2015). For example, this may include combining ethnographic study with GIS to contextualise, identify and understand the complex connections between people and place (Kwan, 2002a; Cope, 2010), or conducting interviews to acquire individuals' perspectives on urban change and compare these findings against the results of the GIS analysis (Pavlovskaya, 2002). Doing so encompasses researchers' motivations to meet their unique research requirements and specifications (Cope, 2010:26), such as triangulating methods, producing knowledge by engaging with the 'other'⁴, recognising context and human 'agency' regarding place production, and/or considering the relationship between people, power and the political.

However, GIS approaches have certain epistemological underpinnings that may be incompatible with those of qualitative methods. As primarily a quantitative and scientific method, GIS has been critiqued of implying a positivist epistemology. However, Kwan (2002a) argues against this. For Kwan (2002a) and Boschmann & Cubbon (2014), GIS is compatible with epistemologies associated with qualitative methods. It can reveal various spatial contexts and connections between people and place, such as the gendered experiences of individuals, to understand human behaviours within their spatial environments. Both Kwan (2002a) and Boschmann & Cubbon (2014) have integrated primary qualitative data with geospatial technologies, to manipulate the benefits of qualitative approaches and understand 'the spatiality of different social processes' (Boschmann & Cubbon, 2014:239). Researchers can use spatial data, spatial analysis, and various cartographic representations as part of a 'social and political practice' for knowledge production (Elwood & Cope, 2009:6). In this

⁴ 'Otherness is the condition or quality of being different or "other," particularly if the differences in question are strange, bizarre, or exotic. Otherness has emerged as a widely discussed mental construct of pragmatic significance in the humanities and social sciences over the last 3 decades.' (Miller, 2008:558).

research, I too provide evidence suggesting that GIS is more than a quantitative tool and argue that social scientists can address key epistemological debates by using these technological systems. I recognise that whilst quantitative methods can measure and present numerical findings and statistics, qualitative methods have a capability to provide the detail and description to facilitate meaning and in-depth discussions to the numbers (Aitken & Kwan, 2010). By using qualitative GIS (Elwood & Cope, 2009), this thesis will further highlight the combining of GIS and qualitative methods, integrating multiple forms of information and subsequent knowledge for innovating data visualisation and cartographic methods for heritage research.

Elwood & Cope's (2009) three-layer framework of qualitative GIS in which GIS can be used for both analysis and representative purposes within research practices is a useful approach informing my project. These three layers (representations, modes of analysis and conceptual engagements) are discussed below:

- Representations

Qualitative GIS can provide snap-shot examples of the 'real world' and its geographic phenomenon through a variety of visual representations (Elwood & Cope, 2009:7). It can provide the 'openings and closures' to research, a metaphor of storytelling with data that enables an engagement with more interpretative forms of information, such as individuals' everyday experiences (Elwood & Cope, 2009:7; Yau, 2011). But these are not without problems or limitations. Schuurman (2009) looks specifically at how information might be lost in the manipulation and representational process, whereby attempts to categorise, or sort the data into specific classes, may remove the context in which it applies (for example, emotions and the reasons for such emotions). If a researcher recorded 'happiness' and 'joy' as emotive responses to landscape, the reasons are often missed out including the potential external influences that may have originally contributed to that emotion being felt. When researchers try to generalise and several responses are the same, there is an assumption that these were all for the same reasons why. Furthermore, there are implications regarding context, as data and subsequent collection methods can never be perfect. Instead Schuurman (2009) suggests that researchers should defend and provide proof of the validity of data through the following discussed modes of analyses.

- Modes of Analysis

Elwood & Cope (2009:8) argue that it is possible to apply qualitative data sources through GIS as part of an ‘analytical intervention’, whereby photos, field notes, sketches and interviews can be used to convey more contextual meanings of data. It is a process whereby detail can be observed through ‘grounded visualisation’ approaches (Knigge & Cope, 2009), exploring spatial data with ethnography. However, this is restricted by the associated scale. For example, observing a macro scale study of census data across a city through aggregated categories (i.e., income or demographic factor), the representation across greater areas can result in more generic assumptions of a population, hiding any anomalies, ranges of data or key correlations. There is not enough detail available to associate specific individual accounts within the visual representation of the area. Smaller scale projects, on the other hand, would present further sub-categories of information, such as postcode areas or local borough. It would be possible to pinpoint key components/factors/landmarks of a local neighbourhood that may contribute to the relationships presented, reducing possibilities of potential ‘discriminatory practises’ that can over-generalise a population (Knigge & Cope, 2009:97). Consequently, maps can be used for spatial comparisons and to observe humanistic trends/paths across a city (Kwan, 2002a). Maps can enrich the approach by being able to offer additional depth, description and detail associated to relationships between people and place, yet still provide supplementary material, background context and quantitative information to support relevant discussions (Jung, 2009). Furthermore, by processing qualitative data sets through GIS systems, it is possible to digitise information and have access to a variety of analytical tools, whilst enabling more effective data management and providing storage capability digitised qualitative data (Jung, 2009).

- Conceptual Engagements

The third layer of this framework highlights the potential to explore other aspects of qualitative GIS through the development of conceptual frameworks, critiquing knowledge and looking flexibly on the ability to visualise non-representational characteristics including emotions, within critical approaches to GIS (Aitken & Craine, 2009; Elwood & Cope, 2009). It requires going ‘beyond the image’ to understand topics and themes beyond those that are represented by typical forms of data representation, and study various social ideologies and critical theories (Aitken & Craine, 2009:153). For example, Kwan (2002a) used GIS to visualise the everyday experiences of African American women in Portland to get a better understanding of their activities and gendered experiences. By situating GIS within feminist geographies, Kwan (2002a, 2002b) called for greater critical engagement between GIS and

critical research and suggested ‘feminist visualisation’ as a practice for reducing the dualism between quantitative/spatial analytical methods and qualitative methods/critical theories. In doing so, Kwan (2002a) created a 3D visualisation model that was able to represent aspects of lives as ‘body inscriptions’, with lines representing women’s life paths, turning these into material expressions of embodied subjectivities. However, regarding the critique of vision⁵, feminist geographers believe that GIS cannot produce a singular representation and the objectifying power of GIS-based visualisations raises concerns for the suitability of GIS methods for feminist research. As a means of knowledge production, users must therefore recognise the partial and embodied quality of vision. Subsequently, GIS can help to reveal the complexity within people’s everyday lives, enabling the interpretation of experience (Kwan, 2002a; Aitken, 2002), providing an effective function of hybridity towards the research process.

Qualitative GIS can combine strengths and attributes from quantitative techniques and strengths of qualitative data sources to reveal meanings and assumed non-representational themes like emotion (Elwood & Cope, 2009). This does not suggest that the approach does not have limitations, but it does support the argument that GIS can be used and studied across a variety of conceptual engagements and topics. Elwood (2010) concludes that researchers should broaden qualitative methods and techniques and use them more readily within integrative mixed methodologies. Qualitative GIS is a key integrative approach to combine information visualization and spatialization with qualitative semantics because it can facilitate more meaningful interpretative analysis. Within human geography and the GIScience, it is possible to do more with approaches that consider ‘more nuanced theorizing’ (Elwood, 2010: 406) and contribute towards ontological discussion, such as those in Kitchin and Dodge (2007) and Kitchin, *et al.* (2013).

While researchers have recognized that GIS is a flexible practice and can ‘fill gaps’ and offer further detail and context where quantitative data cannot (e.g., Elwood & Cope 2009; Yeager & Steiger 2013), there are epistemological issues that link to other areas of geography and the digital aspects of the discipline. Pavlovskaya (2009a) discusses the struggle to place GIS in more qualitative themes of research, though she argues that its residency within cartography and computing has increasingly become better linked to more qualitative forms of research and the spatial sciences. GIS is becoming a strong base for qualitative data to be integrated

⁵ See Haraway (1991), Bondi and Domosh (1992), Rose (1993) and Rocheleau (1995) for more details.

within quantitative areas of geography. Pavlovskaya's (2009a) view must not be interpreted as a limitation of GIS, but more an awareness that while GIS still resides within quantitative research as a key software tool, it provides the technological support to study more humanistic spatial sciences.

'Non-quantitative GIS' considers a reconsideration of GIS as predominantly quantitative, whereby Pavlovskaya (2009a) suggests that GIS' origins were inherently non-quantitative. Whilst GIS requires specialised knowledge from a variety of fields, such as geographical mapping, computer science and remote sensing, this differs to the expertise needed in quantitative analysis. As a method, non-quantitative GIS refers to more practical considerations of how best to collect qualitative data through quantifiable means, though computerisation does not mean quantification. Computerisation has enabled GIS to process information digitally, but again, there lacks any complex statistical procedures. For example, to collect qualitative data through qualitative research methods restricts the use of GIS due the difficulties of applying the data to quantitative software. Instead, the data needs additional transcription and digitisation to make it more manageable by computer systems. As a conceptualised tool, GIS can then provide highly effective analytical capabilities as a useful software resource for visualising spatial data.

Visualisation is the 'most powerful and widely used function in GIS' whereby qualitative GIS is not only a possibility, but where geovisualization also directly supports non-quantitative uses of GIS (Pavlovskaya, 2009a:22). It is a key element that, like other forms of graphical displays, can make information more accessible available for interpretation, and still be a useful and effective analytical tool. In addition, spatial analysis is also less quantitative than users may expect⁶. Basic techniques including overlay, buffering, and the summarising of data within geographic boundaries do not require advanced mathematics. They need 'spatial imagination... logical thinking... intuitive reasoning... [and] qualitative reasoning' to grasp, combine and visually examine geographic phenomena through a GIS program and/or application (Pavlovskaya, 2009a:20). As a qualitative analytical technique, visualisations can be seductive. Through the combination of power from maps, the power of science and technology, visualisations convey not only their associated data, but also power by selectively representing people and place (Harley, 1992, Crampton, 2001).

⁶ See Flowerdew (1998), Openshaw (1998) and Schuurman (1999) for details.

Maps, charts, and other forms of cartographic representations are well-known forms of data communication that convey both the data and the power and authority by which the designer chooses to symbolise and represent categories of information and identified variables (Pavlovskaya, 2009a). However, each form of data visualisation can be contested in terms of validity and correctness. Each representation is dependent upon the researcher, relying on positionality to explain why and how the data has been processed into resulting representations (Dorling, 2012). Whilst there is no doubt that GIS has a wide variety of functions, implications, and capabilities when it comes to geographic enquiry, there will always be a need to question ‘what is happening – who does what, who has what – how do you understand it?’ (Dorling, 2012:11) concerning GIS usage. The development of qualitative GIS or the association of a non-quantitative GIS will always need justification, for critics to accept and understand what message is being given and why the researcher may think this (Pavlovskaya, 2009a).

2.3 Visualising Data

Data visualisation is the ‘representation and presentation of data to facilitate understanding’, being the manipulation and transformation of information into different visual formats, to help users derive a level of understanding from corresponding datasets (Kirk, 2016:19). Visualisation has become a more attractive approach to presenting information, as a way of revealing hidden patterns and trends from within the confines of large, complex datasets (Jiang & Li, 2005). It has the power to exemplify, channel and combine its own strengths through strategies and processes to generate these images or images of data, i.e., cartography and maps. Users and researchers can engage with the story-telling qualities of visualisations, to convey a series of processes and categories through representation, either as static, embedded forms of figures and illustrations within a body of text, or as more interactive, software-based constructs (Segel & Heer, 2010; Lee, *et al.* 2015).

It requires firstly, building some form of data representation that meets the needs and requirements of the data and research, secondly, sharing the data and potential findings with an audience to communicate and share knowledge, and thirdly, receiving feedback and audience responses to find out what meanings and understandings have been communicated to those perceiving the construct (Lee, *et al.* 2015). They follow a chain of progression, whereby items within each image are orchestrated and symbolised in a specific order, to guide the flow and overall narrative presented in the visualisation, such as identified locations on a map, clusters of points, arrows to show direction, and so on. Each unique representation may

be described as a ‘visual data story’ about a specific topic and present a series of facts backed up by data (Lee, *et al.* 2015:84-85). Data visualisations contain both the story-telling elements of a start, a middle and an end, and the design elements for constructing and presenting data representations, to support further geographical enquiry (Yau, 2011; Dorling, 2012).

There are four common chart types used to present different dimensions of a dataset, categorical, relational, temporal, and spatial (Kirk, 2016).

- Categorical Charts

These are used to compare pre-defined groups of information and corresponding quantitative values. They are the most accessible form of representation as they enable visual interpretations of data with minimal time and allow users to observe the range of figures, identify any anomalies or significant differences between categories, and investigate further detail if necessary. For example, bar charts present quantitative values using rectangular bars to represent the value of the category, under the general rule that the greater the height of the bar, the higher the value. Dot plots, pictograms and proportional symbol displays are other examples, whereby the size of a shape/icon is proportional to value.

- Relational Charts

These types of charts are used to visualise the connections and correlations between categories and themes of data and explore the potential relationships between variables, such as demographic factors and the relationship between unemployment figures and health rates. Scatter graphs use x and y axes to plot data relating to a specific category and measure, i.e., the percentage of people of people deemed to be of good health, versus obesity rates also by percentage. Colour is used to distinguish additional dimensions of the data, such as demographic qualities (i.e., gender) or spatial scale (i.e., global/regional), adding further detail for analysis. Another common example is chord diagrams or radial network diagrams, which provide visual representations of the connections both within and between categories of information (Kirk, 2016). Usually presented in a circular display with the circumference labelled with each independent category of data, lines are used to represent the links between each category and are often sized in proportion to a quantitative measure or direction; to view the relationships between categories/themes of data, rather than a linear association of components and their sub-parts (Kirk, 2016). In cartographic terms, using lines to represent connections and relationships is a common method in mapping⁷, alike the use of colour and

⁷ See Phan, *et al.* (2005), Batty & Cheshire (2011), and Jenny, *et al.* (2016) regarding flow amps

symbol size to represent value. They are characteristic of specific types of map explored in more detail, later in this thesis.

- Temporal Charts

Time is a key component in observing change over a specific period. To visualise it, categories of data are collected over a period and their trends/activities presented in one of two ways (Kirk, 2016). The first is a 'time series' where temporal data is plotted by quantitative value (or count) against equally spaced points in time, to view any changing patterns and trends across a specific timescale (Yau, 2013:155), such as the national census of the UK's total population plotted every ten years (Cleveland, 1993; Streit & Gehlenborg, 2015). Line charts are a common method representing the linear development over time. These are often straight, though curved/smooth lines may be used to generalise a trend (Kirk, 2016). The second are known as 'cycles', referring to the patterns that present time in chronological order, like the hours of the day or a pattern of days aligned to the month (Yau, 2013:155). These are more beneficial in a visual context, as they provide the association of time being a continuous cycle with temporal data itself being cyclic. Temporal data is not restricted to just these forms of data visualisation. By manipulating the scales and axis, Gantt charts show the start and end points of a time series (on the x-axis) broken down into sub-categories (on the y-axis), to observe data in order of completion and pinpoint specific milestone dates.

- Spatial Charts

Designed to look at trends within datasets, spatial charts use the spatial quality associated to information to observe the patterns between phenomena and place, either through the overlaying of information, or by manipulating data and distorting the corresponding detail into representative forms (Kirk, 2016). For example, choropleth maps display quantitative values by defined spatial area, such as population percentage by local authority wards across a city in the UK, symbolised using colour scales to provide a visual interpretation of a spatial attribute (Krygier and Wood, 2011; Yau, 2013); darker colours often communicate higher values, and lighter shades communicating the lower. Distortions can be applied to these geographic shapes to proportionally represent the data by area, by inflating or deflating each shape by quantitative measure creating a cartogram⁸. Another example is a dot map or dot density map used to observe the geographic density of sociospatial phenomena (Kirk, 2016). Each dot or point represents a specific numerical value associated to a category of data that can then be symbolised through colour and presented in a key. Though not always necessary,

⁸ See Dorling & Simpson (1999) and Dorling (2012) on cartograms and spatial social structure.

maps are often used as a backdrop to assist in the interpretation of information over a defined place and conduct a visual spatial analysis. Both choropleth and dot density maps interrogate information in relation to geographical area and identified spatial scales. Their use of symbology to present the patterns between phenomena and place is essential to ensure effective, accurate, and reliable communication of findings and subsequent knowledge.

Collectively, data visualisations have the power to contribute to greater fields of knowledge by communicating findings associated to various humanistic themes and concepts, by presenting data for visual interrogation whilst strengthening and contributing to further understanding (Segel & Heer, 2010; Lee, *et al.* 2015; Kirk, 2016). They have begun to evolve and incorporate both the representation of quantitative data and supposed facts, with the qualitative forms of research and subjective detail (Yau, 2011). Whilst the literal act of reading datasets allows users to uncover the tale within the representation, users can approach the ‘who, what, where, and when’ questions to consider the ‘why and how’ (Segel & Heer, 2010:1140). For example, Jeannotte (2016) observes methods for mapping various intangible aspects, such as shared beliefs and societal customs, to better understand the implications of tangible resources including cultural events and organisations. It recognises that whilst intangible culture and other qualitative details may be difficult to record and collect, it is an effective method and tool for exploring place and communicating knowledges about identity and meanings (Jeannotte, 2016). The observer can engage with the societal and cultural contexts that contribute to answers of the how and why questions, using visual narratives to organise media and direct the observer’s attention to key parts of the story; through pictures, illustrations, symbols, and letters as a form of language, to direct the tale being told (Segel & Heer, 2010; Dorling, 2012). They provide evidence of the possibilities to visualise different types of data, using representation to communicate and uncover more through visual interrogation. Visualisations are not limited to communicating just data-informed facts. They can be tools for prompting further exploration and investigation through the perceptions and responses provided by audiences.

My aim is to explore how data visualisation can incorporate both the graphical and quantitative representations with the cognitive and subjective qualities of interpretation, to create bigger, more detailed pictures of social, geographical phenomenon in relation to landscape and surrounding environments. To consider how methods of visualising data and cartographic methods may be deployed as part of a data visualisation package, I begin with a brief history of mapping and cartography, leading to a conversation on data visualisation.

2.3.1 A Brief History of Mapping and Cartography

There is recorded evidence of maps and mapping techniques dating back to the sixth century BC (Garfield, 2013). However, this review will not start the development of mapping from this point, as this would require more than a thesis worth of words. Instead, it starts by recognising the interest in mapping during the British colonisation, when the British were expanding their riches, resources, and power. Maps were seen a symbol of power, but they also conferred power (Garfield, 2013). They became a form of political control and public perception, being more than simple tools to visualise space, and played a key role in asserting and authorising control over territory. Today, they continue to function as a means for showcasing a specific viewpoint of the world whereby maps are more than just an aesthetic creation.

The 1600s showcased the combining of statistical and cartographic skills, being the starting point for many of the first geographic maps (Robinson, 1982). One of the first thematic maps⁹ produced was by Edmond Halley whose 1686 chart depicted trade winds and monsoons across a map of the world (Thrower, 1969). He is recognised as a key thematic geographer, as his contributions lie not only in representations of the earth, but also in thematic ‘geo-cartography’ being the focus on extra-terrestrial phenomena and astrology (Thrower, 1969:654).

The 1700s marked a key development in mapping techniques, regarding the British Ordnance Survey and The Great Trigonometrical Survey of India, which at the time was a British colony (Purdon, 1861; Garfield, 2013). Survey-based mapping had begun to change from a descriptive-based process that was a key part of Indian route mapping, to more mathematical, grid-based techniques that used triangulation. It established a cartographical grid that subsequently introduced fixed reference points for comparing maps and the idea of scalability. As Barrow (2003) and Garfield (2013) highlight, the British mapping of India provided evidence of the selectivity of mapping in relation to their representational power. A map of Calcutta produced in 1842 identified public building including banks and police stations but provided very little indication that it was an Indian city. More specifically, the map omitted details of religious sites, i.e., temples or mosques, that would have helped identify the area and its inhabitants as being Indian. These survey-based mappings with fixed reference points,

⁹ I have refrained from using Robinson’s term ‘data maps’ and instead referred to these as ‘thematic maps’ for clarity and consistency. See Robinson (1982) and Tufte (1983) for details on data maps in cartography.

however, made it possible to create more accurate maps that set the foundation for spatial analysis and map overlays.

Coming into the 1800's, society and economy were two key themes that began to have a resounding impact on the visualisation of data, specifically statistical visualisation. The beginning of the industrialisation era across Europe and the associated high population growth meant that for countries to take better advantage of its increased workforce, countries needed to better understand their political power. With the implementation of the first modern census, there came the realisation that geographical data was not restricted to physical features (Thrower, 1999), as it could also include information of demographic structures regarding the diversification of societies. These highlighted a growing need to create methods of data visualisation that could communicate this information in clear, effective formats, prompting a rise in innovations relating to thematic mapping (Robinson, 1982).

Recognised notably by William Playfair in the *Atlas* published in 1786, early statistical graphics were used to examine territory, population, and financial/monetary power before extending into aspects of society and human life. Statistical graphs and charts were becoming an integral part of maps and other graphical displays of data (Robinson, 1982). For example, Figure 1 below is by André-Michel Guerry titled the 'Crimes Contres Les Personnes' (Crimes Against People) map, being one of the first examples of a thematic unclassed choropleth map, presenting the relationship between variables, like crime and education (Stanford Libraries, 2020a). He believed that these factors could be studied to help improve society. Subsequently, these visualisations began to contribute towards research-based social science and public health, including epidemiology.

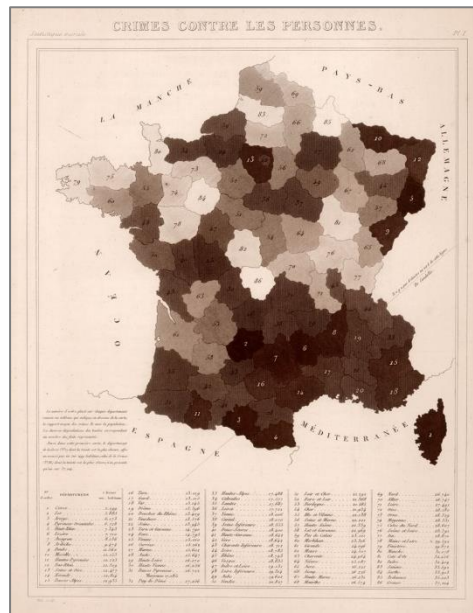


Figure 1: André-Michel Guerry's Crime Map (1833)
(Stanford Libraries, 2020a)

Other iconic maps included John Snow's map of the Broad Street 1854 cholera outbreak, though contrary to belief, it is not the first example of a map¹⁰ used to investigate the relationship between disease fatalities and environmental factors. Disease maps became an increasingly popular and preferred medium for investigating the potential sources of the disease. They were cleverly designed to advocate the theories of physicians and medical professionals prompting the rise in medical cartography. As Rosenberg (1959:37) states, it was a key method of producing 'fabricate [d information, using] a consistent conceptual apparatus', to try and explain phenomena that was shrouded in insecurity and uncertainty. However, whilst this may insinuate that the information presented was false or made up, the fabrication of information refers to the map designer's intent to construct a particular theory and attempt to explain the phenomenon in question. As Garfield (2013) alludes to, maps do confer power and the same applies here whereby maps were often designed to communicate a specific message by presenting selected data and associated symbology in support of a specific belief. The bias nature of the representation is an example of how cartographers use cartographic representations to tell a particular 'truth'. These examples emerged in the late 1700's and early 1800's, the role of cartography in shaping perception and opinion in combination with survey data or statistical information.

¹⁰ See Valentine Seaman's map of yellow fever cases in New York City, 1797 (Koch, 2012) and David Meredith Reece who depicted areas of cholera using a plan of the city

Dr. John Snow's map of the London cholera outbreak was created to investigate how cholera was transmitted amongst the local population, presenting for the first time a correlation between cholera fatalities and contaminated water. In Figure 2, discrete data was collated and represented in point form to produce a map that depicted cholera deaths by address, with the quantity of deaths at each address represented by the number of ticks or dashes.

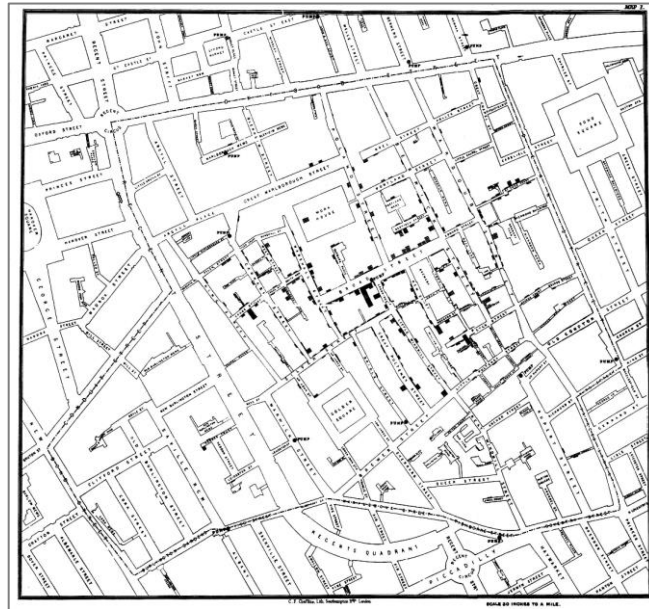


Figure 2: Dr. John Snow's Cholera Case Map, 1854
(O'Brien and Cheshire, 2014)

This was effective as it allowed Dr. Snow to test his hypothesis that the Broad Street cholera outbreak was linked to the water utilities, observing concentrations of deaths in relation to each address and their access to the water supply (Gilbert, 1958). Snow's map enabled a spatial analysis of the disease and population to better understand the cause and source of the localised outbreak.

However, the 1800's produced other innovative representation of data in close alignment with cartography, with graphical displays starting to depict the integrated dimensions of space, time, and quantitative information (Robinson, 1967). This included the development of time-series plots which began to make an appearance at the end of the 1700's, which enabled the user to depict data in relation to specific time intervals. Notably, designs by Johann Lambert presented several dimensions, such as his periodic variation in soil temperature that also considered the depth of the soil under the surface (see Tufte, 1983:29). To this day, modern examples of time-series plots differ little in terms of their design, albeit that today's graphics are usually based on much larger databases. Charles Minard's 1869 Carte Figurative of

Napoleon's advance and retreat through Russia between 1812-1813 (see Figure 3 below), is another example that Tufte (2001:40) claims is 'the best statistical graph ever drawn'. Depicting Napoleon's journey across Russia, Figure 3 below incorporates statistical information about time and the army's size and communicates the details in a clear and efficient form.

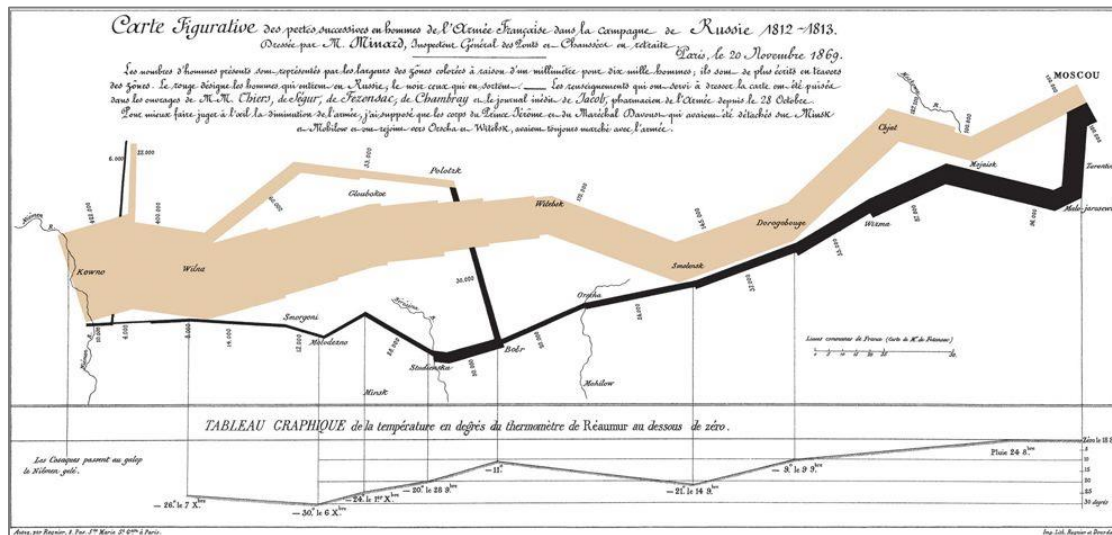


Figure 3: Charles Minard's 1869 Carte Figurative of Napoleon's Grande Armée Advance and Retreat through Russia, 1812-1813 (Tufte, 2002)

Primarily concerned with the presentation of statistical data in graphical formats, Minard also utilised several other techniques associated to a thematic approach, either adapted from older versions or 'new' to the time (Robinson, 1967). These included flow maps depicting passenger traffic and pie charts of population density, with his concern for accuracy demonstrated in respect to each representation, such as the width of a flow line being strictly proportional to magnitude. For example, Figure 4 below demonstrates Minard's attention to detail, being of the use of colour, annotation, and cartogram designs to visualise the flow of cotton to Europe between 1858 and 1861 (Stanford Libraries, 2020c). The flow width represents quantity whilst the colour symbolises one of five exporters. Additionally, the annotations for quantity are angled regarding the direction of flow. The cartogram quality is demonstrated using distortion, whereby the basemap has been manipulated to better present the data.

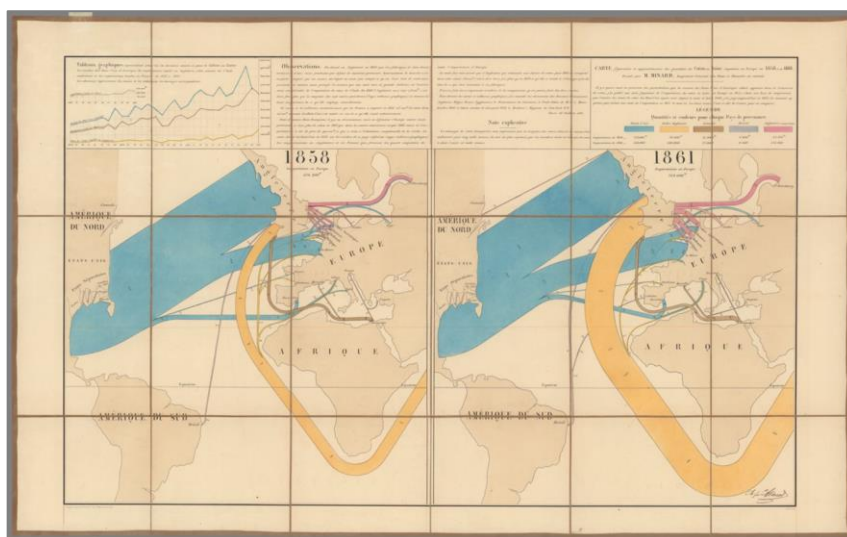


Figure 4: Charles Minard's 1861 Map of Cotton Imports 1858-1861
(Stanford Libraries, 2020c)

The development of statistical graphics and more modern examples of data representation can often be traced back to the 19th century, with the creation of line graphs, bar charts, and rose diagram charts (Stanford Libraries, 2002a). Between 1850 and 1900 there was an 'explosion' of innovation regarding graphic methods and visualisation becoming known as 'Golden Age of Statistical Graphics' (Friendly, 2008a:502)¹¹. Lambert, Minard, Snow and Playfair all contributed graphical techniques during this era, with the addition of Baron Charles Dupin [1784-1873] who used continuous shading to represent a statistical measurement, such as light to dark, to communicate geographic distributions of phenomena (Friendly, 2008a). More specifically, with the rise of statistics and the collation of statistical data, the creation and development of population maps is also significant. Some of the earliest examples, including Dupin's map of French illiteracy in 1819 and André-Michel Guerry's Crime Map (1833) mentioned previously, used techniques that are not dissimilar to the methods cartographers use today. For example, Figure 5 below presents Dupin's map, which translates as a 'figurative map of popular education'. It depicts number of male pupils within a 'département' under primary education instruction, using continuous shading to illustrate the disparity of education between the north and south of France (Palsky, 2008:3).

¹¹ A more extensive overview of the visual display of statistical data and information visualisation, including some of those stated in this review, is provided in the 'Milestones' project by Friendly and Denis (2001).

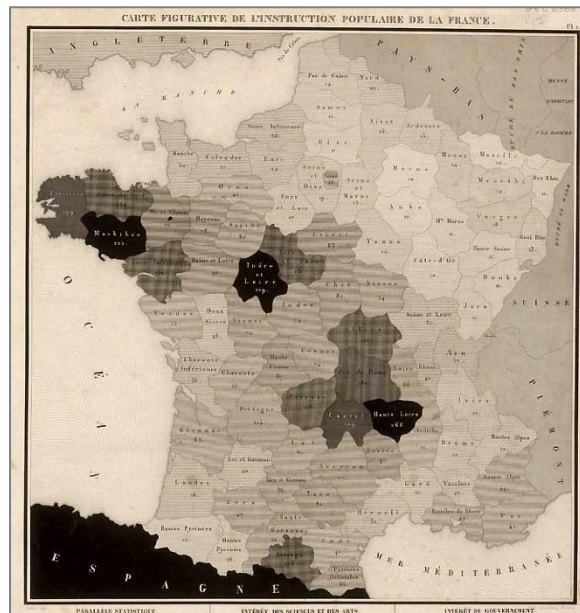


Figure 5: Baron Charles Dupin's Carte Figurative de l'Instruction Populaire (1826)
(Palsky, 2008:4)

Dupin did not provide any information about how this map was designed and created, nor did he provide a key to explain the contents of the map. He did, however, emphasise a major geographical break by using visual effects to present the trends and patterns between datasets. Notably, this method was later used to present other humanistic themes, such as crime and education, and was adopted by André-Michel Guerry to explore the relationship between other variables. It serves as an earlier example of the subsequent choropleth mappings within this review. In addition, 1830 also saw the introduction of a dot map that depicted the population of France, created by Armand Joseph Frere de Montizon (Friendly and Denis, 2001) and presenting data based on regional administrative units (départements). In his map one dot represented 10,000 people and provided a means for representing count data more effectively than the early choropleth maps (Friendly, 2008a). This too follows the earlier work of Dupin by combining graphical methods with systematic data collection, to present information about important issues of the time.

Understandably, there was little advancement regarding cartography and data visualisation at the start of the twentieth century, as it brought with it two world wars that demanded the attention of society. Friendly and Denis (2000, 2001) refer to it as the 'modern dark ages of statistical graphics' and the 'rebirth' of graphical displays did not take place until the 1950s, with developments fuelled by the introduction of the computer, computer processing and associated programs, with the ability to recreate old representations in new graphical forms (Friendly and Denis, 2001).

The 1960s saw the creation of Canada Geographic Information System (CGIS) and this was considered the first GIS (Poiker & Craine, 2006). However, digital cartography did not take off quite as quickly as expected, due the weak technical capabilities of the first computers¹². Though these challenges meant that there was less incentive to turn to mapping digitally, Friendly (2008b) signposts that this did not prevent the introduction, and sometimes reinvention, of graphical techniques and associated data visualisations. Towards the second half of the 1980s, computer technology then began to advance rapidly, becoming an important tool for cartographers in the design and creation of maps. By the 1990s, the development of technology and availability of computers both at home and at the office, meant that GIS and associated techniques were soon part of the mainstream. With the increasing GIS software options alongside the launch of earth satellites for satellite imagery and integration of remote sensing, several applications were soon developed, and GIS began to appear in the education, business, and government sectors across the world (Steenson, 2019). By 1992, Goodchild had introduced *Geographical Information Science* (GISci) (Goodchild, 1992), being a field that aims to redefine geographic concepts and their use whilst examining the implications of GIS on society and vice versa (Mark, 2000; Mark, 2003).

Furthermore, the success of electronic mapping can be traced back to decisions made by the United States Geological Survey (USGS), to make their datasets available online for free. This decision meant that software companies could focus on the technical developments and improvements knowing that their users would have access to readily available, high quality data. This got even easier when USGS debuted ‘The National Map’, being a collaborative effort to improve and deliver information about the US to its users (Usery, *et al.* 2009; USGS, 2020). Today, computer cartography and cartography are often seen as one in the same, due to the availability and associated capabilities of existing technology, software, the internet, and access to open-source data. However, this does not discredit existing hand-based cartographies, as there are existing practices and pieces of research that utilise these approaches. The computer has been a catalyst in the creation of new innovations, practices, and approaches, contributing and furthering the field of cartography more digitally within the twenty-first century¹³. There are now vast quantities of methods for creating digital maps, that

¹² See Chrisman (2005) regarding ‘How Computer Mapping at Harvard became GIS’.

¹³ One such example regards the development of population maps and cartograms. See Raisz (1934), Tobler (2004), Dorling & Fairbairn (1997), Dorling & Barabási (2006), Monmonier (2007), and Ballas & Dorling (2011).

alongside the automation process, has enhanced the ability to process and analysis data; specifically, the emergence of GIS and its ability to handle, analyse and represent spatial data. GIS has been able to bring together geospatial data analysis with data visualisation, furthering the abilities of geographical enquiry.

Digital Cartography

The transition of cartography into a more digital world, regarding the vast availability of software and increased capabilities of today's technology, has meant that anybody can have a go regardless of their (lack of) training, background and/or experience. Cartography and map-making have transitioned from their professional origins to one where anybody with access to a computer and GIS can create a digital map. The increase in technology has enabled the creation of easy-to-use mapping tools and software, whilst the internet has provided a platform for users to create and share their results with a global, internet-based audience (Kraak, 2003). However, digital mapping was initially more focused on developing the first multitasking operating systems regarding multimedia capabilities (Hennig, 2016). The shift to digital mapping process occurred at a quicker rate than the methods and principles associated to cartography (Robinson, *et al.* 1995; Dent, 1999).

Similar can be said of data regarding the increasing availability of socio-economic datasets via the internet. The regular release of national datasets and increased quantities of information relating to the physical environment, has resulted in data becoming more public and readily available, which in turn has a significant effect on how the data is used, presented, and analysed. The introduction of the census in the 1800s and the mapping figures discussed previously are examples of users sourcing and accessing data for their own empirical research, whilst the USGS' decision to release high-quality and free datasets was a pivotal point for expanding public engagement. The rise in software and web-based applications have resulted in increased opportunities for both professionals and public users to explore and interrogate data and create various visualisations and cartographic forms. They provide additional avenues of enquiry to develop and investigate new approaches to cartography and geography more widely. However, the growing amounts and availability of data also contain challenges that users need to be mindful of. Secondary datasets have several limitations including how the data is generated and collected, for whom and their motives and agenda, and the assumed reliability and trust that users associate to various online sources (Kitchin & Tate, 2000).

Arguably, digital technology has also made map making and geographic visualisation more complex (Hennig, 2016). The creation of new types of visualisation and analytical techniques requires specialist training and experience alongside specialised computer environments, to explore and understand the development of new practices and approaches. In this thesis, GIS software is the main tool and platform used for this research though there are an abundance of others with the capability to digitally map and create data visualisations. The definition provided in section 2.2 outlines GIS' key purpose for spatial analysis and the integration of a variety of data, however, as is recognised later (see section 2.3.2), software often lacks elements of good cartographic practice for creating effective, innovative mapping approaches and visualisations. The maps themselves can present the results of various analyses, but they lack the necessary design principles to communicate a clear message or story from the generated display. However, I agree with Hennig (2016) that the creation of new tools and applications have since been able to offer inexperienced users the opportunity to create representations of their own and encourage further engagement with digital cartography.

Geospatial analysis is a key part of the GIScience discipline whereby digital mapping is more than just the digital design, but also iterative process of analysis and data processing prior to the end visualisation (Kraak, 2008). Specifically, visually appealing maps all start with data collection, management, and entry into some of software/GIS whilst the end representation is the result of having processed the inputted data through an analytical technique. However, the process does not stop here. The outcome requires further drafting, editing and more mindful consideration of design principles and mapping conventions, to create a more meaningful cartographic representation. Furthermore, Slocum, *et al.* (2008) and Cartwright (2011) imply that GIScience has prompted the digital changes in cartography, but the visualisation aspect has left cartography altogether. Maps and other map-related representations have become a key method for making sense of geospatial data and presenting geographical information, whereby there is little distinction between cartography and data visualisation.

In the case of presenting qualitative data about people's perceptions and behaviours, this thesis claims that cartography can be used as part of a data visualisation package for investigating the relationships between people and place. To do so, the thesis must acknowledge the underlying visualisation concepts and cartographic theories for creating effective geovisualisations, to present data through more effective forms of knowledge communication. It considers maps as more than just a form of representation or aesthetic

creation; they are a form of visual communication that can facilitate further thought and exploration (Kraak, 1998).

2.3.2 Data Visualisation

In this review, the data visualisation discussion explores both data graphics and cartographic representation as a way of looking at these fields within the context of the research. The chart types outlined previously¹⁴ address how different styles of data graphic can present different dimensions of data. Specifically, categorical, relational, and temporal charts can present categories of data, relationships between variables, and trends occurring over time. Spatial charts, however, require a spatial element associated to the corresponding information to map spatial patterns using overlays or distortion. In addition, cartographic representations and geovisualisations require geographically referenced data, whereas data visualisations more broadly do not. However, this thesis does recognise ‘spatial charts’ as one of four categories of data visualisation and this does offer some overlap to cartographic representation, as spatial charts can contain mapping elements. (Kirk, 2016). In this case, this chart type will be discussed in relation to cartographic representation.

Whilst cartography and data visualisation differ in characteristics and different categories of visualisation are designed to present specific data dimensions, elements from the different categories can be used in tandem with one another. These differences can be blurred, and users are able to ‘break the rules’ by creating new, innovative forms of data visualisation. Hence, the thesis claims that maps as a form of cartographic representation can be used as part of a data visualisation package, either as unique standalone innovations or as complimentary and supplementary methods of visualisation. This will become evident later in this thesis.

Data Graphics

As the previous section has alluded to in the brief history of mapping, the creation of data graphics emerged during the eighteenth century with Lambert, Playfair and Minard being key figures in the development of data visualisation. It required considering more abstract measures that could be used to replace the latitude-longitude coordinates of a map and design representations that did not rely on geographical principles. In 1801, Playfair published *The Statistical Breviary* containing four plates that presented graphics containing multivariate data (Tufte, 1983; Stanford Libraries, 2020a). Figure 6 below is one of such plates, using pie

¹⁴ See section 2.3 Visualising Data

charts to represent the area of identified countries whilst the axes indicate population in millions and revenue/taxes in millions of pounds.

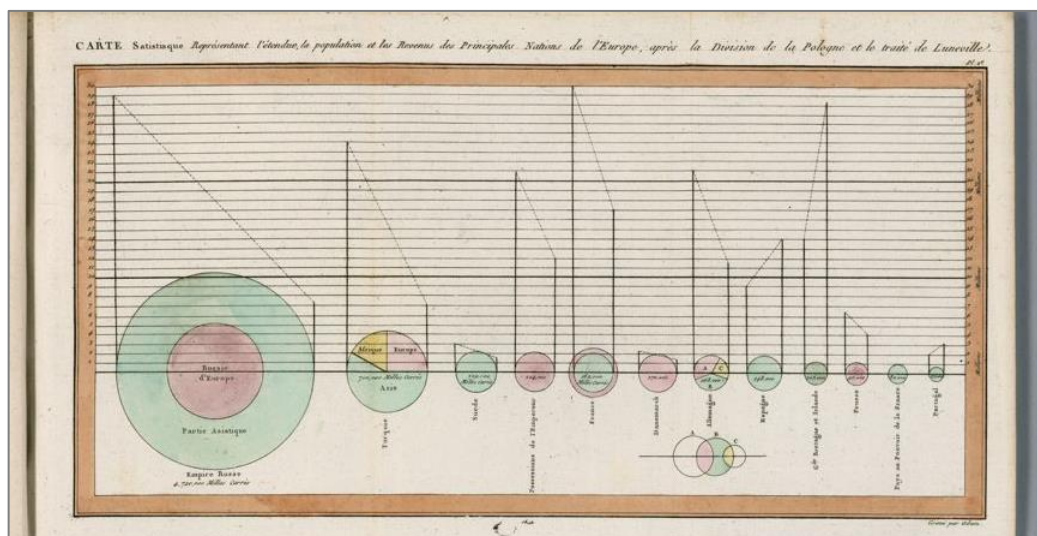


Figure 6: William Playfair’s 1802 Principal Nations in Europe: Extent, Population & Revenue
(Stanford Libraries, 2020a)

As Playfair recognised in 1786, there became an increasing need to try and make sense of the complexities associated to society and life. Today, this is no different due to the increasing availability of data and information about a variety of structures which too, make up society within the twenty-first century. Playfair understood that data representations would enable individuals to convey information to an audience, albeit whether these misinformed or did so successfully (Bertin & Berg, 2010). However, whilst Howard Wainer suggests that Playfair provided some of the foundations for graphic practice, Playfair did not explain why the representations worked nor did he associate any relevant theory (Bertin & Berg, 2010). Bertin's work on graphics was one of the most important publications to appear because it did offer an understanding of how best to communicate information and data. It considered why certain graphics were better for either analytical or presentational purposes.

Originally published in French in 1967, Bertin's focus was on how to represent quantitative data on paper, with his work subsequently producing a 'grammar for graphics' (Bertin & Berg, 2010: ix). Today, his work is still as important due to the increasing capability of hardware and software provision, including web-based and open-source examples, meaning any individual can produce a form of graphic at will. Like the transition of cartography into a more digital world, the vast availability of software and increased capabilities of today's

technology has meant that anybody can create a data representation and do so in disregard of necessary design principles, understanding the purpose and function of associated visualisations, and how best to use these to facilitate information and data visualisation. As Wainer points out in the preface of Bertin & Berg (2010), software itself is not designed with fool-proof default settings, producing data displays that often inaccurately present and misinform the users and audience. Subsequently, this thesis supports Wainer regarding the importance of paying attention to design principles. Without them, it would not be possible to create data visualisations and cartographic representations that can effectively communicate findings, whilst minimising the risk of misinforming and/or misleading an audience. Within this thesis, there are examples of graphics and associated works that have built on the work of contributing figures, contributing the necessary insights and knowledges that need to be a part of graphical practice.

Between 1930-1970, graphics were designed with two ‘assumptions’ in mind. Firstly, graphical displays had to be overdecorated and exaggerated to compensate for ‘boring statistics’, to keep the audience engaged and intrigued (Tufte, 1983:53). Secondly, the purpose of the analysis was to detect and declare any evidence of deception. However, by the 1960s, John Tukey had begun to change these perceptions with displays that enabled users to effectively explore complex data (Tukey & Wilk, 1970). Graphics became ‘instruments’ that focussed less on the creation of a set of standard practices and design principles, and instead enabled reasoning about quantitative information. However, this is not to say that deception was entirely ruled out. Graphical displays can still lie and/or exaggerate a specific viewpoint, but as an area of research, there is less focus on identifying any acts of deceit and the associated liars and deceivers. As Tufte (1983) previously states, graphical excellence can only begin if users tell the truth¹⁵ about the data.

Offering insights into how best to display information, Tufte’s ideas came from the perspective of graphical artists who presented data in newspapers, yet his ‘Principles of Graphical Excellence’ (Tufte, 1983:51) are typically applied in all areas of graphical design. Graphical excellence is ‘the well-designed presentation of interesting data’ (Tufte, 1983:51) which consists of communicating complex ideas with clarity, precision, and efficiency. In

¹⁵ Here, the use of the term ‘truth’ may cause conflation regarding arguments made by Critical GIS researchers, studying the relationship between GIS and society (see section 2.2.1 Critical GIS). In the context of section 2.3, it regards the ability to tell stories with data in clear and effective formats, without exaggerating or oversimplifying the data, nor hindering the recipient’s ability to decipher the presentation.

doing so, presentations can allow users to interpret a variety of ideas without requiring long periods of time to decipher and make sense of the representation. Good data graphics will maximise the ‘data ink’ being the ink which represents data, whilst removing unnecessary details and elements that will hinder the presentation (Tufte, 1983:93). By doing so, users can acquire a degree of integrity¹⁶, referring to how accurately the visual elements of the presentation are able to represent the data. Subsequently, the purpose of a graph is to tell a story and/or advance an idea by simplifying and clarifying the presentation of it is narrative, and to do so requires following key rules. As Tufte (1983:191) summarises regarding the display principles that help users to generate design options,

‘What is to be sought in designs for the display of information is the clear portrayal of complexity. Not the complication of the simple: rather the task of the designer is to give visual access to the subtle and the difficult - that is, revelation of the complex.’

In other words, simplicity is key to promote engagement and understanding.

Today, visualising data encompasses a wide range of techniques, strategies, and styles and these too must adhere to strict design principles, to ensure that each one can function effectively as a visual form. Outlined by Kirk (2016), these principles are underpinned by the contributions by Bertin, Tukey and Tufte, and their influence is evident in the detail. Firstly, visualisations must be trustworthy and provide a degree of accuracy and legitimacy regarding the represented datasets. Representations must not mislead nor provide false communications of information, though a truthful data visualisation can be disputed against. Secondly, data representations must be accessible and incorporate useful, understandable, and unobtrusive qualities. If deemed useless, the visual product will not communicate relevant information, nor provide enough detail and depth to warrant an analysis. If the product is ‘obtrusive’, the visual content becomes inaccessible to users, often where the representation has too many functions and roles (Kirk, 2016:42). Similarly, the format of the representation can also limit accessibility, whereby the amount of content can hinder readability, making the representation too complex. Thirdly, data visualisations must be elegant whereby the designer will have met the needs of the data and presented information in a valid and justifiable way, thoroughly and meticulously drafted, and edited the design process, to ensure the style and decoration adds further quality and assists in clear communication of information. When each criterion is met, visualisations can enable users to perceive and query what the data representation is showing

¹⁶ See Tufte (1983) regarding the six principles of Graphical Integrity.

them, interpret and investigate further what the visualisation may mean, and comprehend what the visualisation may mean to them (Kirk, 2016:22-23).

Cartography

Cartographic strategies are a method of presenting spatial data through a variety of graphical means. On one hand it is a computational perspective that allows users to interpret and transform data through identified approaches, whilst on the other it encompasses a cognitive approach relating to spatialisation¹⁷ and the visualisation of human perception in relation to geographic space (Skupin & Fabrikant, 2003, 2007). Having explored previous chart types, different data types require different approaches for visualisation, and this is no different for cartographic representation. More traditional forms of cartography use structured data and can be applied more directly to various software programmes. Unstructured data requires additional pre-processing, such as content analysis and text data¹⁸, to make data suitable for computation and spatialisation. Semi-structured data is an approach that describes the structure of information and employs ‘schemas’ that identify the spatialised context for extraction (Skupin & Fabrikant, 2003:97). This thesis predominantly uses unstructured data in relation to the exploring what strategies and techniques can be deployed to create more qualitative forms of cartography. It is therefore necessary to incorporate approaches and methods that can collect qualitative information in manageable, processable forms, as part of a more integrative methodology. This consequently enables the spatialisation of qualitative records for mapping and visualisation. I will later¹⁹ identify the research methods used to collect people’s perceptions of place, and the techniques for quantifying these responses for computational and analytical processing in GIS.

Robinson (1952) argued for a more objective, scientific approach to creating cartographic representations, stating that the primary function of a map is to communicate information to the reader. Eckert (1908, cited by Griffin, 2017:44) had initiated this idea in the early 1900s, by identifying ‘map logic’ as a topic that could observe the laws which underpinned the creation of maps and how these were received through cartographic perception. He argued that to underpin this, researchers needed to apply psychological theories and research to establish the laws to underpin map logic and consider perception and cognition in relation to

¹⁷ See Skupin and Fabrikant (2003) and Skupin and Fabrikant (2007) regarding ‘spatialization’.

¹⁸ Cooper & Gregory’s (2011) work on ‘Mapping the English Lake District: A Literary GIS’ is an example of this and discussed later in this thesis.

¹⁹ See the following Chapter 3.0 Approaching a Mixed Methodology

map use (Eckert, 1921, cited by Griffin, 2017:44). Cartographers and other researchers alike, therefore had, and still have, a responsibility to develop design principles that make this form of knowledge communication more efficient and effective. Cartography therefore became a communication paradigm and between the 1960s and 1990s, it was the most dominant way of thinking about maps and mapmaking.

Robinson (1952) was a strong advocate of the ‘form should follow function’ and with Eckert’s appeal to apply other fields of research to support a more scientific cartography, he did so in *The Look of Maps*, arguing that the purpose of scientific cartography was to communicate knowledge from the scientist to the map user. By the 1970s, understanding the transmission of information and the relationship between cartographic design and map perception became a key focus, considering how decisions on design could influence what a map user interpreted from a map (Griffin, 2017). Drawing on Eckert’s map logic, cartographic communication research was established to define the principles of ‘map language’ (Ratajski, 1974), exploring the communications between a map maker and the map user, to understand how information could be communicated between the two. There are two key factors (visual perception and visual cognition), which together have helped cartographers and researchers alike better understand how a design/form can enforce functional map use. This includes the use of graphical marks (i.e., map symbols) and colour choices.

Visual perception²⁰ is a process that occurs between the receptors in a person’s eye and the nervous system, whereby a detailed pattern is analysed by the centres of the brain that control attention and memory. From here, the visual centres of the brain inform the individual of what they have seen. (Hochberg, 1998; Braddick, 2001; Schriber Orloff, 2004; Baars & Gage, 2010). In cartographic terms, this process is significant in symbol design whereby map perception relies on visual perception to effectively construct cartographic symbols that convey accurate mapping information (Wood, 1968; Żyszkowska, 2016). Żyszkowska (2016) suggests that maps have specific graphic and conceptual properties, like images, and the ability to receive the intended message relies on functionality of the visual system. In this case, the authors of maps must distinguish between the message being communicated (i.e., the signal) and the graphical marks and symbols that can deter understanding of the intended it is impossible for every single feature to have a unique, identified symbol, because a) there are

²⁰ Visual perception in this context regards the process relating to the visual system and the brain’s ability to make sense of what a person can see. This does not relate to visual impairments and the associated complexities of the process itself.

not enough icons to display every different factor, and b) they would not fit onto one map design cohesively. Researchers must consider how to reflect aggregation within their results, using symbols to either represent the ‘centre of mass’ of a series of clusters or to cover a general area (Monmonier, 1996:28). If a map has three groups of clusters that sit relatively close together, is it better to define each of the three clusters respectively, or indicate their location and associate size to the number of points recorded? It depends entirely on the goals of the researcher and the purpose of the required cartographic representation. message (i.e., noise and unnecessary map information) (Griffin, 2017).

Gestalt theory is one such principle that, alongside visual hierarchy, can help cartographers achieve more effective communications of the messages they intend to share. Visual hierarchy is the principle of separating and arranging different elements of a map across various ‘depth planes’ in relation to importance (Wood, 1968; Griffin 2017). Each ‘plane’ will contain a specific selection of graphic information that with Gestalt theory, psychologically, the map user can group cartographic symbols in relation to the hierarchy of those planes. For 2D static maps such as thematic maps, like those observed later in this thesis, this requires a balance between the relevant information to a perceptual hierarchy from the figure-ground²¹ (Bertin, 1983; Fabrikant & Goldsberry, 2005; Żyszkowska, 2016). In addition, cartographers must be mindful of pre-attentive processing, where to the viewer, certain features on a map will stand out more easily than others. For example, it is harder to distinguish between shapes of the same colour, than it is to assign each shape a designated colour. It is also difficult to distinguish shape difference at a glance because it is not a pre-attentively processed. Users can distinguish the differences in colour much more readily, but additional visual searches and deciphering are needed to fully understand the presented message (Fabrikant & Goldsberry, 2005; Fabrikant, *et al.* 2010; Griffin, 2017). These factors are key to consider, when creating cartographic representations as methods of communication.

Colour can also be a problem in the effective communication of a map’s message. As alluded to previously in the discussion of digital cartography and electronic mapping²², the availability of technology and the computerisation of map production has meant that associated software often lack the necessary design principles to effectively communicate the map’s message. Regarding colour, the most well-known colour model is the ‘Red, Green,

²¹ Figure-ground being the extraction of information through identified symbols, from the background of the map itself (see Żyszkowska (2016) and Bertin (1967/1983)).

²² See section 2.3.1 A Brief History of Mapping and Cartography

Blue' (RGB) model, which is a system used to represent colours through digital, computerised displays. There is also the 'Hue, Saturation, Values' (HSV) model, which is used to describe colour in terms of their shade and brightness values (Junhua & Jing, 2012). Each one specifies an individual shade/hue of colour that has been associated to each land use class. In cartographic terms, Kovesi (2015:31) argues that RGB colours are not ideal because of the human eye's 'perceptual insensitivity' to determining different variations of colour. HSV values, however, are used because of their capability to associate a broader range of colour scales, which are better determinable by the human eye. They are used to pinpoint and define the colours more specifically, so that when finished map products are produced, no matter what software, printing system or publisher the designer users, that specific colour would be the result (Junhua & Jing, 2012). If colour was defined by name/title, these tend to vary between software packages and programmes therefore removing a degree of consistency and restricting the replicability of the map (Monmonier, 1996). Notably, there are now well-known colour schemes included in many map design software but also in data graphics design and statistical analysis software. Specifically, the ColorBrewer which provides users with a guide on how to select appropriate colour schemes for specific mapping needs (Harrower & Brewer, 2003; Brewer, 2003).

Similarly, like the differentiation between map symbols and the visual hierarchy, human discrimination of visual symbols is also key for producing effective map symbols. When it comes to understanding the message presented, users must be able to discern the symbology within the context of the map (Griffin, 2017). In keeping with the colour example, the figure below provides an example of the difficulties of effectively interpreting datasets based on the issue of simultaneous contrast. In this example, the two identified shapes are the same colour and present the same data values, but the polygons adjacent to them appear to be 'competing' in hue, causing difficulty in determining the map contents.

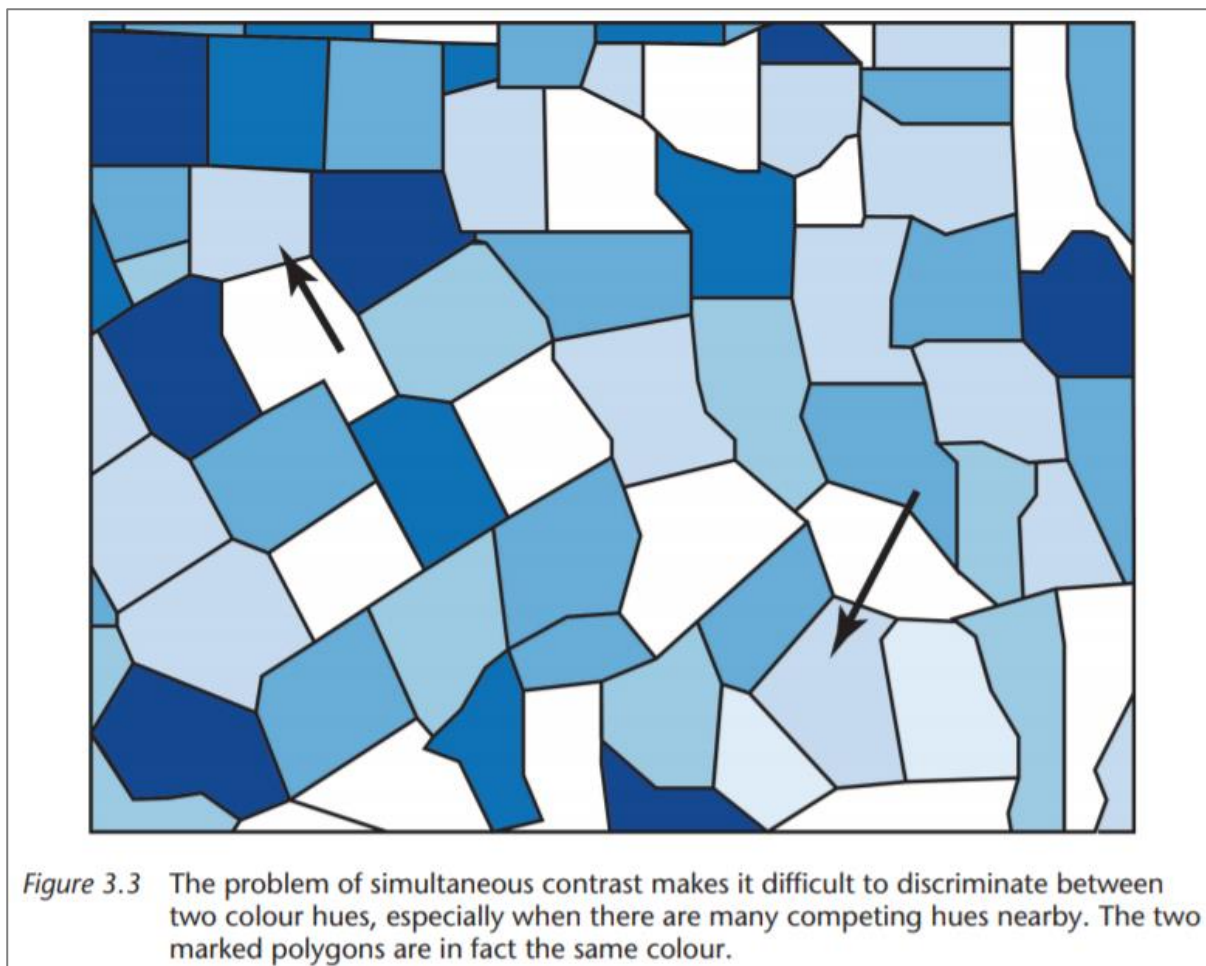


Figure 7: ‘*Figure 3.3*’ Simultaneous Contrast and Colour Hues (Griffin, 2017:48)

Colour preference can be a social, cultural factor, whereby choices are dependent on their use and research preference, so colour allocation must be a conscious effort made by the researcher/cartographer. Monmonier (1996) explains that individuals often subconsciously link colours to themes, objects, emotions, and meanings, mistaking them for their intended use purpose and representation. The colour red is often associated to fire, love, courage, anger, and the Labour party, whilst the colour blue is often associated to the cold, the ocean, peace, the Conservative party, and the mind. Subsequently, colour classifications and their meanings require further clarification regarding why colours have been chosen and what makes them suitable for this representation. Their content needs to be transparent and easily accessible for viewers, to ensure that each map can communicate its information clearly and concisely.

Visual cognition is the combining of visual data with prior knowledge and understanding, enabling individuals to develop high-level representations (Vernon, 2016), though notably, some of the earliest cartographic practices and research did not consider cognition regarding

map use. MacEachren (1995) explains that what a person may see on the map is not only influenced by the graphical marks, but also their level of experience and knowledge of reading maps. This also includes the subject engrained within the map and individual expectations. The cognitive paradigm emerged towards the very end of the 1960s and early 1970s, where Neisser (1967) suggested that mental processes were vital for understanding how mental representations were constructed. A key approach for understanding cognitive processes was the development of eye tracking, introduced by Leon Williams in 1970 at the 'Symposium on the Influence of the Map User on Map Design' in Canada (Steinke, 1987, cited by Griffin, 2017). This prompted several experiments and associated research discovering that there was a plethora of viewing patterns by map readers, though importantly, individuals did spend more time interpreting the informative parts of a map (Jenks, 1973; Dobson, 1979).

Robinson's 'form should follow function' re-emerges here in relation to cognitive processes, whereby eye tracking was often used to investigate the relationship between map design and the cognitive processes that map users employed (Steinke, 1987 cited by Griffin, 2017). It became clear that maps could, and still can, effectively support users with a specific task but only if they guide the user and direct attention to the informative parts with minimal effort. How users interpret a map is therefore based on the ability to store and retrieve this information as part of a cognitive structure (Downs and Stea, 1977; Slocum, *et al.* 2001; Montello, 2002; Fabrikant, *et al.* 2010). MacEachren (1995) suggests that to guide map users, both general and specific map schemata can be deployed irrespective of a map users prior experience and training. This may include more general schema, such as map legends that provide an explanation of a map's content, whilst more specific map schema can provide further detail, such as colour choice or symbol size representing temperature or quantity. One such example is Dykes, *et al.* (2010), whereby their experiments with map legends suggest evidence for more effective ways of communicating statistical distributions. In doing so, these maps can do as Bertin (1983) suggests, they can be 'seen' rather than having to be 'read', who's later work and that of other researchers, have made attempts to formalise map schemata (MacEachren, 1995).

ESRI²³ propose five key design principles that cartographers need to apply when compiling their maps and creating geovisualisations: visual contrast, legibility, figure-ground organisation, hierarchical organisation, and balance. Whilst figure-ground organisation and hierarchical organisation (i.e., visual hierarchy) are also evident in Griffin's (2017) prior exploration of visual perception and visual cognition, these are not unique factors or independent principles. They are complimentary to one another. To expand further, visual contrast regards the ability to distinguish features and page elements in relation to one another and the map background. In cartography, a high degree of visual contrast can result in a crisper, cleaner looking map, whilst a lower contrast can present a more subtle impression (Buckley, 212). Legibility is previously alluded to and regards the ability to see and understand a map, its message, and associated contents. It supports the other design principles by ensuring clarity though depends on good design choices. Balance is also a vital part of cartographic design, whereby the organisation of a map can promote a certain impression, drawing on visual weight and visual direction to guide the user towards certain aspects of the map. Hence, careful consideration of a map's design and acknowledging principles identified, it is possible to create an effective map.

However, not all maps are designed as communication devices. Geographic visualisation, or geovisualization as is now commonly known²⁴, emerged in the early 1990s whereby the integration of information from a variety of sources was part of the wider practice of using maps to think and reason regarding geographic problems and presented phenomena (MacEachren & Monmonier, 1992; Griffin 2017). MacEachren & Ganter (1990) proposed a new model that suggested maps could be more than communication devices, whereby 'seeing' the organisation of knowledge through a variety of schemata, users were directed towards a specific conclusion and associated reasoning with opportunity to interpret maps at their own discretion. Whilst a map needs to communicate patterns, trends, and support the communication and generation of knowledges, doing so with enforced structure and direction can limit the interpretation of the findings and reduce opportunities for further exploration.

To summarise, visualising data draws on an extensive range of strategies and techniques that require an engagement with associated design principles to communicate information

²³ The Environmental Systems Research Institute (ESRI) is an international supplier of geographic information system software. Notably, they build ArcGIS being 'the world's most powerful mapping and spatial analytics software' (ESRI, 2020).

²⁴ See section 2.2 Geographic Information Systems

effectively. Graphics will improve with iteration, evaluation, and reflection (Tufte, 1983). To an audience, data graphics need to be interesting and sophisticated without underestimating the ability of the perceiver to understand the representation, whereby some designs will be self-explanatory, whilst others will require a little more engagement, especially the new, more innovative designs. Cartography also encompasses a range of methods for presenting information, explicitly spatial data. These too require engaging with necessary principles to facilitate visual perception and accurate map interpretation (Wood, 1968; Żyszkowska, 2016). However, maps can be more than a tool for communication. Whilst designers need to be aware of the relationship between map design and cognition, the integration of information and organisation of knowledge through map design principles risks flexibility of the perceiver to interpret information more independently and in relation to their own skills, knowledge and understanding (MacEachren & Monmonier, 1992; Griffin 2017). Furthermore, the increased availability of software and capabilities of technology within the twenty-first century has prompted cartography and map-making to transition from their professional origins to a more public domain (Robinson, 1995; Dent, 1999; Hennig, 2016). This is not just the case with cartography. Tufte (1983) too felt that there was a lack of quantitative skill of graphical designers, being predominantly trained in the fine arts and with little experience of data analysis. Those who can create beautiful graphics and make statistics more aesthetically pleasing, reinforce the assumption that numbers must be exciting and embellished to make them more appealing. Subsequently, creativity often supersedes skill and accuracy, hence the need to incorporate and understand the design principles associated to different themes of data representation.

Considering data visualisation as a method for exploring and investigating data, I will further the previous critical GIS discussions and Yau's (2011) propositions of storytelling through data narratives, to introduce grounded visualisation. Grounded visualisation has been chosen to underpin this thesis as it goes beyond the act of representation and presentation by acknowledging two analytical methods as part of an integrated approach: grounded theory, and visualisation. It has a focus on constructing theory and knowledge from the initial coding and sorting of social information into defined categories, to the utilisation of key visualisation methods for presenting an assortment of information and data types.

2.3.3 Grounded Visualisation

Grounded visualisation is an approach to both exploring and analysing spatial data and ethnographic datasets, drawing upon the analytical methods of grounded theory and

visualisation (Knigge & Cope, 2006, 2009; Elwood & Cope, 2009). Grounded theory is an approach to collating, coding, and sorting data into specified categories, to enable a comparison of various data types, i.e., interview transcripts, focus group notes and various other data sources (Knigge & Cope, 2006, 2009). Its focus is to construct theory about various aspects of the social world, building upon the lived experiences of people, their behaviours, and actions, and how these are influenced by other broader contexts, such as historical factors and geographical themes, socio-economic position, location, cultural influences, and societal norms (Knigge & Cope, 2006). Visualisation is the second approach, which Yau (2011) refers to as a medium for providing ways of exploring, presenting, and expressing the meanings of data. It is not only a tool for communication, but through a geographical lens visualisation has the capability to story-tell with data by revealing hidden meanings and messages from within datasets (Yau, 2011). Consider a coin with grounded theory on one side and visualisation on the other. On one hand, there is the purpose of grounded theory to collect, code and organise the data for analysis, to begin theorising information and identify categories of information and patterns. On the other, visualisation techniques are the response to this action, providing opportunities to construct visual formats, using software like GIS to create various data representations. Together they have a parallel motive to build upon current and newer knowledges by exploring information and identifying themes and patterns that raise new questions and ideas, contributing to the development of newer concepts and theories (Knigge & Cope, 2006, 2009).

There are four key areas of commonality between grounded theory and visualisation that contribute towards this analytical approach: exploratory powers, iterative and recursive processes, the particular and the general, and representations of multiple interpretations (Knigge & Cope, 2006, 2009). Exploratory powers require questioning data and making use of various visual techniques to produce representations of assumed explanations (i.e., the relationships between variables and/or testing of various theoretical connections). Once spatial information is encoded through map making, it is decoded through interpretation from the resulting data visualisations (Downs & Stea, 1973; Knigge & Cope, 2006, 2009).

Researchers can use this iterative spatial analysis process to recursively explore datasets, looking for evidence of specific concepts and theories through patterns and trends, to fuel further discovery and enquiry. Researchers can investigate different scales of information, such as the micro and macro, the specific and generic, to look for connections between people's behaviours and responses and find further evidence of broader concepts and theoretical processes (Knigge & Cope, 2006). For example, this includes investigating how

individuals respond to their spatial environment by observing their adaptive behaviours and considering how best to represent these multiple interpretations of data.

The fourth commonality can be either complementary or contradictory of the phenomena that they are associated to. For example, multiple interpretations of the same genre have a capability to provide different perspectives on a topic and ‘fill in gaps’ where information may be missing from other data sources (Pavlovskaya, 2002, cited in Knigge, 2006:2028). On the other hand, these interpretations can also suggest discrepancies within research but still be classed as ‘true’ interpretations. Two individuals may have differing opinions about housing developments on green belt land, however both responses are unique representations of the perceptions by each person. It creates a greater incentive for researchers to explore their data more thoroughly, to either find out more about a topic and draw a more complete picture, or to find out why there may be discrepancies and what new areas of information these may hold (Knigge & Cope, 2006). When all four commonalities are considered as one grounded visualisation, the collated data can either present as full a picture as possible, or selectively tell only a snapshot or part of it.

Grounded visualisation as an approach facilitates the designing of new maps capable of presenting qualitative information spatially. Specifically, grounded visualisation can help to explore sociospatial data by enabling individuals to observe perceptions in relation to identified locations, patterns of behaviours across geographic areas, and the potential links between human agency and the environment. As an approach, it can facilitate the combining of qualitative data with quantitative spatial information, to provide more meaningful, more in-depth considerations of the complex relationship between people and place (Seegers & Giordano, 2015; Franke, *et al.* 2017). The sorting and subsequent coding of information provides the initial level of analysis that allows researchers to navigate their way along the emerging narrative, to constantly compare and decipher between each set of collated data and use the results derived from grounded theory to inform their analysis of testing of emerging patterns and trends (Kwan, 2013, Kwan & Schwanen, 2016). It can also incorporate a temporal dimension to the resulting data representation, making comparisons between various categories or themes of data to observe the developments and changes over time. Consequently, grounded visualisation underpins this thesis because it can be used a tool for exploring the relationships and connections between people and place. GIS can help to further the principles of grounded visualisation by providing the technological and computational capabilities to deal with a mixture of data types and sources, creating opportunities for further

geographical analyses. Cartographic representations can therefore communicate trends and provide the means to visually interpret the differences in relation to location (Kwan, 2013, 2016; Franke, *et al.* 2017), contributing to the creation of new knowledge (Seegers & Giordano, 2015).

2.3.4 Power of Mapping and Cartographic Representation

As previously referred to, Robinson's drive for a more objective/scientific approach to mapping resulted in the theory that mapping is a process of transmitting geographic information, or transferring geographic knowledge, from the cartographer to the map-user, using the map as a 'vehicle' of communication (Kent, 2018:99). Originating in information theory, maps became a 'visual system of correspondence' and Robinson (1952) was adamant that functional design needed to take a central role in the map-making process (Wilson, 2017:74). His publication the *Look of Maps* emphasised the need to consider map design, map structure and other design principle and qualities, to make clear and effective use of cartographic techniques. He later published *Elements of Cartography* (Robinson, 1953), and this became a key textbook for Western cartographic practice. Introduced by Keates in 1964, the first published map communication model was produced by Moles (1964, cited by Kent, 2018:99) and followed by Board (1967, cited by Kent, 2018:99). The paradigm was designed to acknowledge the various operations relating to the creation of maps but also the communication system regarding how cartographers saw their role (Board, 2017). The most influential however, was Koláčný (1969), who according to MacEachren (1995), addressed the lack of engagement with map use and the selective nature of the map to present a selective observation and transform it through various models into cartographic language and map symbols.

Emerging from some of the first explorations of the map communication model, came the theories that strove to understand the factors affecting map use and a desire to control these to ensure a map could fulfil its role and function. Crampton (2001) explains that as the need for an improved map design was recognised, research focused on user-testing, bringing the map-user into a more significant role in research. For Koeman (1971), the use of the term 'vehicle' as a metaphor for the flow of information between the map, the mapmaker and the map-user regarded the use of graphic symbols. Koeman (1971) believed that the problems regarding truth, accuracy and the overall function of a map could be solved by a set of universal standards for which all mapmakers would adhere to, the goal being to obtain clarity in the communication process (Crampton, 2001).

From behavioural cartography came the emphasis on the heterogeneity surrounding the practices and reading of maps and their users (McCleary, 1987; Wilson, 2017). Specifically, Bertin (1967) had warned cartographers about the potential problems relating to movement in cartography, in addition to the focus on functional map design of static maps. Very few researchers at the time of McCleary (1987) had considered the map-user as a recipient and the role of maps in environmental cognition. Asides from Downs & Stea (1973) and Kaplan (1976)²⁵, it took the efforts of Michael Wood and Christopher Board to realise ‘cartography is a behavioural science’ (McCleary, 1987:351). McCleary (1987:352) explains it as:

‘From the environment information is directed to the human; the human responds with behavior. Information is stored in the cognitive atlas [as] experiences... vicarious information [i.e., map reading] ... and imagination’.

Maps guide behaviour, such as navigation and more constructive and destructive activities like architecture and war, as well as attitudes and values. The key point here linking behavioural science to cartography, is not the process of transmitting communicating information to a user, but that the information has had some effect in the role between human interaction and environment.

To take functional design more seriously and consider the research on map-reading and map-user behaviour, it would require altering all known principles, standards, and conventions, to align with map reading behaviour (Wilson, 2017). The notion that the map-reader was no longer universal was an important step in recognising that for a map to effectively communicate information, it had to do so to a diverse audience. Map design research was therefore required to understand the tasks carried out by map-users, but also their creators, enabling new map innovations, approaches and associated interactions (Montello, 2002). In this case, movement was not an additional variable, as Bertin appears to imply, but an expression (MacEachren, 1995). As alluded to previously, eye tracking²⁶ became key to contributing scientific rigour in studies of map use and Harrower & Fabrikant (2008) too argued that by better understanding human cognitive processes, it would be possible to assess graphic displays for efficiency and acquire a better understanding of the relationship between visual displays and the human visual processing system (Dorling & Openshaw, 1992, cited by Wilson, 2017). Notably, cognition for improving the use and design of maps became

²⁵ These are just two notably examples where map-users were of interest and regarding the role of maps and environmental cognition.

²⁶ See section 2.3.2 Data Visualisation

increasingly popular in the twentieth century, to understand maps, mapping, and associated approaches. Montello (2002:283) notes that cartographers have long recognised that ‘maps *represent* the world by providing versions of truth for human minds to apprehend,’ and that in turn, the human mind represents the world as a form of ‘cognitive map’. However, it was not until the twentieth century that the field of cognitive cartography applying cognitive theories and methods to map use and map making has become a formal part of the discipline of cartography (Montello 2002).

As with the rise of technological capabilities and computational power, additional avenues and opportunities have opened for both cartographers and the public to develop and create new approaches within cartography²⁷. The transition into a more digital world has shifted cartography and GIS from more professional origins to those of public access. Software packages do not necessarily have design principles written into their programs, nor do all users have cartographic training. However, whilst Koeman (1971) believed that map communication problems could be resolved with a universal set of rules or standards, a degree of creativity is often needed to communicate patterns and trends through more specific design principles and approaches, whilst ensuring a balance between the manipulation of principles and the represented information. Original findings can be manipulated to show more about reality than what can be originally perceived, by exaggerating categories and/or themes of data to get a clearer picture of the connections and relationships between specific factors. For example, some of Dorling’s (2012) work on cartograms uses this artificial reality to create images that better explain spatial phenomena. Specifically, the size of polygons is manipulated to represent, for example, population size, rather than the physical area size. However, this does not come without its limitations. There are potential issues of ‘artificial reality’ whereby images/illustrations that appear grand and striking in both quality and context, often are because they are manufactured versions designed by exaggerating (and sometimes simplifying) corresponding data (Dorling, 2012:59). It is a reminder²⁸ that maps have a power to provide too ‘true’²⁹ meanings of their presented datasets, often making assumptions and conclusions too believable and consequently reducing the legitimacy of data and its display (Pavlovskaya, 2009a:23). Critical GIS and critical cartography scholars have questioned the objectivity of mappers when manipulating information in this manner, as the

²⁷ See section 2.3.1 A Brief History of Mapping and Cartography.

²⁸ See Chapter 2.0, section 2.2.1 Critical GIS

²⁹ The use of the term here encapsulates both Tufte’s (1983) notions for telling stories with data in clear and effective formats, and those of critical GIS researchers regarding the power that underpins the creation of a map.

resulting images are representations created by the author rather than geographically accurate duplicates (Harley, 1992; Law, 1994; Schuurman, 2000).

For neo-Robinsonian cartography, being the ongoing progression of understanding maps and their practices, there is a need to continually evaluate and strengthen the more objective aspects of cartographic practice. It draws on the system of 'map-user-reality' by furthering Robinson's arguments and understanding the role of principles within cartography, including map function. Movement, balance, harmony, and proportion, however, are subjective elements of cartography that are often deemed problematic, being those that 'exceed the drawn lines fixed on the page and screen' (Wilson, 2017:77). One of Wilson's examples to illustrate the complexities of representing space and time is Doreen Massey's work. Doreen Massey was a key figure in conversations on space, time, and representation, and within geography more specifically, she asked individuals to think beyond the more basic assumptions regarding spatiality, liveliness, and spatial representation. She argues that the imagination of space is limited to dominant forms of representations and associated themes whereby spatialisation removes 'time' and fixes representations in place (Crampton, 2001). In the case of animated maps, maps are reduced to a series of perceptual relations and space becomes stasis, whilst trying to resolve the inadequacies of static maps (Massey, 2005). It creates another system of 'space-representation-stasis', that intensifies the representational tradition of geography, but without necessarily addressing the issues of spatial immobility and stasis. As Dorling suggested in 1992, a map does not necessarily have to be fixed and developments in animation are welcome, however maps still need to communicate the complexity of spatiality. Subsequently, to incorporate movement, balance, harmony, and proportion into cartographic representation requires a more flexible set of standards to govern their use (Robinson, 1952), and a new conceptualisation and conceptual developments that engage with these more subjective elements., Wilson (2017) argues that it is possible for maps to operate more affectively, by acting beyond the elements of cartography that can be measured for effectiveness.

Kitchin & Dodge (2007) argue that cartography is better conceived as a process rather than representational. They question the 'ontological security' of maps and believe cartography should be considered as 'ontogenetic' in nature, that maps emerge through practices and have no secure status. In terms of an ontological crisis, Kitchin & Dodge (2007) refer to the work Robinson and his focus on creating maps with systematic detail and design principles that have kept the map user at the forefront of its creation, for effective portrayal of information

that a map reader could extract, analyse, and interpret (Robinson, *et al.* 1995). On one hand, this 'scientific' approach is better placed within cognitive science and/or visualisation principles, whereas on the other, critical cartographers question the rationale with little reference to the technical aspects (Crampton, 2003). In this case, Foucault and Derrida suggest that mapping is therefore not a neutral, objective pursuit, but is inherently 'laden with power', (Kitchin & Dodge, 2007:332), i.e., every map has an author that requires subjective decisions to be made about the map, its contents, look and layout (MacEachren, 1995; Monmonier, 1996). The critique of mapping as a 'powerful' process outlines that maps are tools for knowledge communication based on the subjective decisions and positionality of the author. Maps therefore have what Dodge & Kitchin (2000) refer to as a 'second text' woven within and throughout the presented representation. Drawing on critical social theory, researchers argue that GIS is far from the 'neutral' product-making tool it was originally conceived though the problem was with how the map was used (Wood, 1993).

Furthermore, maps can be more than just objects by also 'being in the world' and open to various discourses (Kitchin & Dodge, 2007:333). Maps can provide a snapshot of phenomenon corresponding to the times in which they are created and should be considered regarding their conceptual frameworks, to explore how they are framed to make sense of the world. Maps are as 'problematic' as texts because they are neither authored or read in a simple and straight forward way (Kitchin & Dodge, 2007:334). Maps need to be deciphered and not necessarily to reveal the truth, but to understand the denotations and connotations about the map's power (Pickles, 2004). However, Kitchin and Dodge (2007) argues that Crampton (2003) and Pickles (2004), while viewing maps as complex, rhetorical devices, still position maps as ontologically secure, which remain 'as spatial representations that say something about spatial relations in the world (or elsewhere)' (Kitchin and Dodge 2007, 334). Kitchin and Dodge (2007, 335) further argue that maps are ontogenetic, in that they are 'of-the-moment, brought into being through practices (embodied, social, technical), always remade every time they are engaged with; mapping is a process of constant reterritorialization.' Kitchin and Dodge (2007) thus argue for a shift from ontology to ontogenesis, a position to understand maps as always mapping and becoming. Developing on from Kitchin and Dodge (2007), cartography has reportedly shifted from representational, to post-representational, to processual (Kitchin, *et al.* 2013). Kitchin and Dodge (2007) argue for a shift from ontology to ontogenesis, a position to understand maps as always mapping and becoming. To rethink the epistemology of cartography, researchers shift their focus from the

rules techniques and applications to questioning how maps emerge through a plethora of practices and discourse as part of this processual perspective.

Maps are always in constant production and as Kitchin, *et al.* (2013) stated, are always in a state of ‘becoming’. Maps are not restricted nor limited by the media upon which they are created and represented, as the duality of production and consumption are constantly (re)created with every opening/use. Arguably, maps are mobile and infused with meaning through ‘contested, complex, intertextual, and interrelated sets of socio-spatial practices’ (Del Casino & Hanna, 2006:36). Del Casino & Hanna (2006) suggest that maps should be theorised and understood as a process, quite alike the offerings made by Kitchin & Dodge (2007) and Kitchin, *et al.* (2013). However, Del Casino & Hanna (2006:36) are ‘interested in pushing our methodological (and by default our epistemological and ontological) assumptions and processes toward thinking of maps as spaces.’ Maps are both a representation and a practice that are read simultaneously (like a coin).

Subsequently, maps may not be communicative devices, but representations that require semiotics and the analysis of signs to understand both the individual and societal level of geographic visualisation (Wood and Fels, 1986; MacEachren, 2004). Because maps are susceptible to a range of interpretations, are notably contested and liable to change (i.e., data/user/context), the semiotic approach considers how these meanings interact. The maps and meanings are (re)constructed by the user, who in turn brings in their own positionality and experience to the process, whilst the map itself can ‘yield’ a multitude of other representations within one form (MacEachren, 2004:459); ‘they “develop a consensus about letting symbols (in the broadest sense of the word) stand for objects, relationships, events, and the like, in the ‘real’ world’ (MacEachren, 2004, 14). This process is, of course, never complete, as map-users can produce a multitude of interpretations’ (Del Casino & Hanna, 2006:40).

In the next subsection, I discuss the ‘existing consensus’ concerning the use of symbols in mapping, with a focus on mapping qualitative data.

Principles for Mapping Symbolology

Providing clear data visualisations with accessible, easy to read data representations is vital for clear and effective information communication (Kirk, 2016). Specifically, cartographic representations utilise aspects of symbolology to provide context for visual perception, using

recognisable icons and principles of colour to support the articulation of mapping content to a desired audience (Monmonier, 1996; Żyszkowska, 2016). Data must match their corresponding symbols, signs, keys, colours, and other representations, to ensure an effective symbology is in place (Krygier & Wood, 2011). However, this process relies not only on the symbolisation of numerical values, but also the data type. Qualitative data requires some form of categorisation that can then be visually represented to portray differences, i.e., the shape or colour of a specific symbol that corresponds to a topic/concept/theme. Quantitative data on the other hand requires representations that can reflect numerical information, whether these are to portray magnitude, scale, direction or counts, i.e., the size or colour of a specific line, shape, or point (Krygier & Wood, 2011). A commonality between the two is the use of colour to represent data clearly, suggesting that there is greater importance in acknowledging and understanding how best to apply colour to data visualisations. In this thesis specifically, the maps created use HSV values to pinpoint the colour ramps, because they have a capability to provide a greater variation of colour and are arguably more distinguishable than those of RGB value (Junhua & Jing, 2012).

Colour serves to make maps aesthetically pleasing, attractive, and able to communicate cartographic context (Monmonier, 1996). It is a common method of symbolisation where different colours can be used to distinguish categories of data, implemented to symbolise the magnitude of the data sets through variations of colour across a colour ramp (Kirk, 2016), i.e., counts, ranks or derived values, such as rates and percentages. Quantitative values are better communicated using colour values through scales (i.e., black to white, red to blue) as these better represent an amount or measures/counts and allows the viewer to associate colour saturation to value, i.e., the darker the colour, the greater the value. Qualitative data is better presented through independent colour hues, where categories are given unique colours (i.e., red for one category, and yellow for another), to better differentiate between groups of information. However, colour must be appropriate without restricting the reliability and validity of the data. Often, maps that are deemed impressive and visually striking are often invalid and useless whereby the focus is on their visual, aesthetical qualities rather than functionality and reliability.

Observing mapping principles more specifically, GIS as a tool and the maps it can produce can assist in the exploration of data, with the correct application of principles. In relation to this thesis specifically, this section discusses the mapping principles associated to choropleth mapping and proportional symbols, using Brewer's (2006) work on visualising cancer data.

Specifically, categorical differences between datasets may include socioeconomic categories such as race, education, and income. To symbolise these, Brewer (2006) suggests that categorical differences are better represented through colour hue and symbol shape, whilst quantity is better represented by colour lightness and size. In choropleth mapping, as noted previously, these use colour lightness to communicate values by area, whilst proportional symbols use size to represent quantitative data. Data must be normalised in accordance with the geographical area in question. Brewer (2006) suggests that a sequential colour scheme³⁰ is better suited to choropleth mapping (i.e., yellow-green-blue) because they reflect the sequential nature of the dataset. Choropleth mapping also requires data classing, being the grouping of data values into either quartiles, equal intervals, or Jenks (also known as natural breaks). To do this effectively, cartographers should use histograms to assist in their choice of classes. Proportional symbols also require the same data classing process, though these are more suited to count data and are placed directly on top of identified points. The larger the symbol, the greater the value is the general rule, and these too can be used to present data ranges like choropleth mapping.

Presenting various map elements for the final map is another integral part of the cartographic design process. This includes a map title that presents the topic of the map and any map sources, data sources and authorship should be placed in a small font at the bottom. Typically, the size of the fonts will guide the reader sequentially through the content of the map, the largest being the title (i.e., the start), the legend slightly smaller though bigger than any additional detail/description, and the smallest being the credits (i.e., the end). Map projection is another key element, though arguably should be considered before the mapping process begins. In GIS software like ArcGIS, there are a range of basemaps available to provide reference and context for various projects, with each created using an allocated geographic co-ordinate system. If users are incorporating their own basemap data, they must attend to the correct projection to best present their data as distortions can interfere with the accuracy of the representation and reader's judgement.

Brewer (2006) suggests that maps and data graphics do have a story-like quality by playing a key part in the initiation of a project, and the final analyses of various data representations.

³⁰ I have already alluded to the issues of colour in cartographic practice, regarding the technicalities of using computational software and programmes. Choosing an appropriate colour scheme, however, can be difficult hence the ColorBrewer guide provides valuable information for selecting appropriate colour schemes for specific mapping needs (Harrower & Brewer, 2003; Brewer, 2003).

With GIS specifically, it is possible to expand the use of the tool and consider the possibilities that either a single map or a collection of can do to illustrate data and communicate knowledge. GIS is therefore a complimentary tool for visualising and exploring data, before, during and after the research process regarding the final presentations. To do so effectively relies on identifying appropriate mapping methods and associated symbologies, such as those identified through choropleth and proportional symbol mapping.

In relation to mapping emotions, Caquard & Griffin (2018) suggest there are three themes to approaching emotional cartography: 1) the emotions that are placed on maps, 2) the emotions which emerge as part of the mapping process, and 3) the emotions which occur in response to maps. In the context of this research, this thesis will focus on the first point, emotions that are placed on maps. Previous examples of research including Osborne & Jones (2017) and Osborne (2018) recorded bodily reactions to environments using digital devices alongside GPS receivers, to plot and record responses visually. However, these scientific measurements require a human to unpack what the information means, whereby mapping emotions requires being able to identify the emotion and characterise it, whilst considering the spatial extent. One way of doing this is through PGIS, where participants can locate their perceptions and emotions within a specific location, through a series of mapping exercises (Pánek, 2018). The points allow the participant to precisely locate the places where a specific emotion was felt, as well as having the benefit for being aggregated and visualised later. The purpose here was not only to record the data, but to have participants actively map their emotions toon and actively reflect and explain the context of the information given. However, another challenge is acknowledging that different emotions will mean different things to different people, especially between different age generations, languages, and cultures (Caquard & Griffin, 2018).

Consequently, it is necessary to observe forms of visualisation not only as a product of representational tools and software, but as methods designed and defined by the data types they aim to present (Dorling, 2012; Kirk, 2016). Visualisations have an ability to tell a story and communicate narratives from within corresponding datasets, but only if the user understands and acknowledges the strengths and limitations of each chart type. Furthermore, there is a need to associate a grounded visualisation approach to not only associate an exploratory and analytical capability, but to help guide the integration of qualitative and quantitative data through GIS ready for spatial analysis and representation (Knigge & Cope, 2006, 2009; Elwood & Cope, 2009; Rucks-Ahidiana & Bierbaum, 2017). Spatialisation is a

means of applying spatial analysis to the intangible and subjective, to uncover more about social, geographical phenomena through cartographic representations, encouraging users to engage more critically with their collated datasets (Skupin & Fabrikant, 2003; Rucks-Ahidiana & Bierbaum, 2017). It allows users to analyse qualitative data through spatial methods and processes, visualise patterns and possible correlations between people and place, and acquire more meaningful understandings of the relationships between society and space as part of the analysis and story-telling process (Knigge & Cope, 2006; Rucks-Ahidiana & Bierbaum, 2017).

Additionally, map symbology can be as difficult as understanding a foreign language. I need to ensure effective data communication to provide the ‘what’ and the ‘where’ contexts through a clear map legend, subsequent symbology, and effective geographical scale, to facilitate the ‘how’ and ‘why’ questions through further analysis (Monmonier, 1996; Krygier & Wood, 2011). These presentations can add further context and depth as either a supplementary resource or basis of spatial analysis, strengthening the reliability of interpretations regarding observations of landscape (González-Puente, *et al.* 2014). Hence, chosen symbologies must be justified in line with the target audience and function of the map. Different maps require different representational techniques that can support the communication of information, where the map type must match the requirements and specification of the researcher and their data. Visual variables must link not only to the map type its purpose and function, but also provide a clear visual representation for observing the patterns, trends, and potential correlations. Whether these are as counts and measures, or indications of specific geographical phenomena, the graphical marks that are used to represent the concept therefore have an important role and responsibility to communicate information and further resulting knowledges (Krygier & Wood, 2011).

Radical Cartography: Breaking the Rules

Alternative routes of thinking about and visualising place regards radical cartography and the mapicity of the visualisation to possess qualities that liken it to a map product (Denil, 2018). Whilst a map can be identified, perceived, and read, maps require a coherent structure and order and requires the more formal attributes and aspects of a conventional map, to enable readability and use. Denil (2018) suggests similar ideas to Wood and suggests that maps have a series of schema that enable map literacy: 1) a vocabulary, 2) a grammatical syntax of application, and 3) idiomatic practice. In Denil’s (2018:1) case:

‘a map is a map because a map literate reader recognizes a set of attributes in the artifact: attributes that signal to the reader that the artifact in question is a map, and that then go on to guide the reader's employment of the artifact as a map.’

Mogel & Bhagat (2007:6) define radical cartography as a practice, which ‘subverts conventional notions in order to actively promote social change... [with the intention to] unhinge... beliefs about the world, and to provoke new perceptions of the networks, associations, and representations of places, people and power.’ Their publication, *An Atlas of Radical Cartography*, presents a series of maps consisting of flow maps, route maps, graffiti, a map mashup, and other pieces, each containing a series of layers in which the reader must engage with to decipher the narrative presented. The purpose of the work is to consider space as a form of construct, developed through experience, use, formation and reflection, because maps are descriptions, depictions, and methods of enquiry in space. These considerations are reflected in the ideas of Kitchin & Dodge (2007), Kitchin, *et al.* (2013) and Massey in Wilson (2017), proposing further that maps both shape and reshape space, giving it meaning by enabling multiple layers of perception and interpretation through visual representation.

A key question to ask then is, how maps can express or present ‘geographies of human experience and place’ in response to the available geographical tools and technologies (Pearce, 2008:17). One such approach is to move away from more traditional cartographic methods, to other more ‘expressive forms’ such as sketch maps and drawings. Specifically, Pearce (2008) suggests that conventional cartographic language, the graphics, and visual grammar are a basis for devising expressions of place. Features of a map are categorised and arranged regarding visual hierarchy, divided into points, lines, areas and other assortments of categories that require symbolisation, such as size, colour, and shape (Crampton & Krygier, 2005). By expanding cartographic language, researchers can also include expressions of language as part of cartographic practice. For example, Wood & Beck (1976, 1989) explored the use of graphic symbolisation in the use of sketch mapping, as these provided a way of reflecting a person’s ability to handle a map and any potential anxieties for those who did not. By devising what they termed Environmental A, it was possible to represent space as it was experienced by the individual, using an alternative cartographic language. Wood later suggested an alternative approach to map reading and called for cartographers and researchers alike to consider maps as a form of narrative. Like Yau’s (2011) metaphor for metaphor of storytelling with data, this required the literal action of reading a map like a book or form of

text and his conceptualisation was therefore key to understanding how maps were organised, ordered, and arranged in a particular sequence, influencing viewer engagement³¹.

Similarly, PGIS also encompasses a common technique for integrating experience within cartographic representations. Using GIS' ability to represent various layers of information, researchers³² can give 'experience' its own layer and apply this to more conventional maps, whether these take the form of digitally imposed sketches or renderings by combining GIS with various medias. Cieri (2003, cited by Pearce, 2008) explored the representations of lesbian places and associated perceptions in Philadelphia. Using the writings of her participants and various provided sketches, she was able to superimpose these onto a MapQuest street map. Kwan (2008) is an additional example where this research turned oral histories into visual narratives by taking the stories of participants and turning these into visual representations in GIS, tracing their life paths through activity data. In these examples, the graphic map and/or basemap, is created through the conventional methods of cartographic language and connected to human agency through an affective overlay of data composed of experience and memory. On the other hand, O'Sullivan (2006) notes the critiques of GIS, the use of PGIS, application and neutral position of the technology. He suggests that users do not undermine the epistemology, philosophy and practices associated to GIScience and naively assume that GIS is as malleable as users suggest. Whilst technology may be bringing people together and empowering individuals to use GIS and contribution to various projects and decision-making processes, a framework is still needed to make it as effective, flexible, and usable as other existing tools.

For this thesis, whilst the role of the map is not an inherent part of understanding or investigating heritage geographies, it is a line of enquiry that could be expanded further, to consider the binaries through mapmaking or map use and how the processual nature of maps may contribute/frame the perceptions that individuals create in response to experience and space (see Kitchin and Dodge, 2007 and Kitchin, *et al.* 2013). Subsequently, I introduce the following section on experiencing heritage landscape. I explore Wylie's (2007) conceptualisation to understand how people see landscape, whether as an image, text, or physical object, but that it can also be a process of persuasion guided by both material and

³¹ See section 2.3.2 Data Visualisation regarding the discussions map logic and visual perception, which later refer to map design principles.

³² See Pearce (2008) for further details of Cieri (2003) and Kwan (2007). See Kwan (2002, 2008) also, who is referenced within this thesis.

intangible qualities (Duncan & Duncan, 2010). I expand further on heritage landscape experiences, to investigate the formulation of interpretations and responses to identified environments.

2.4 Experiencing Heritage Landscape

Landscape as a term is problematic. Landscape can be the focus of an investigation, serving as either a specific object or thing to test, query and hypothesise, or as a lens for researchers to interpret and construct empirical studies (Gregory, *et al.* 2009). It is associated to art and history, to administrative and political connotations of boundary, jurisdiction and community, and work that focuses more specifically on the subjective through cultural studies. From a human geographical perspective, I argue that landscape is therefore a tension. It is the pressure to pinpoint whether landscape is between ‘proximity and distance, body and mind, sensuous immersion and detached observation’ (Wylie, 2007:1). To underpin this thesis, I have drawn upon the work of three key figures to support my explorations of people’s perceptions and experiences of landscape: Carl Sauer (1889-1975), William George Hoskins (1908-1992), and John Brinckerhoff Jackson (1909-1996).

Sauer suggests landscape is a real, solid, and objective thing, quite literally a field that individuals can immerse themselves within, and studied as part of a geography (Wylie, 2007:20). From a cultural perspective, it is more than the boundaries that define it and the areas in which people can perceive. Landscape is the adaptability, human agency and social diversity that can shape and change the natural, physical environment, to portray aspects of culture through the land (Wylie, 2007). However, critics suggested this ‘Sauerian’ approach focused too heavily on the physicality of space, and not so much on the intangible aspects of culture (Wagner & Mikesell, 1962, cited by Wylie, 2007:27). Landscape and its features were instead markers created by human response and reaction on a timeline of ‘depth, richness, and complexity’ shaped by ‘cultural age’ (Wylie, 2007:32), a process that Hoskin’s argued addressed a range of individual societal attitudes, and furthered critical engagement. Jackson conceptualised that landscape incorporated a sense of locality and a degree of materiality based on the immersed and lived-in experiences of individuals (Wylie, 2007). Termed a vernacular landscape, it incorporated themes of adaptability, culture and residual matter left by human agency, to consider the long-term processes and impacts upon society made by specific cultural groups. Landscape is not just a physical thing upon which societal and environmental processes occur, it encompasses the intangible, the material, and presents evidence to support the construction of perception and identities.

Sauer, Hoskins, and Jackson's contributions to research are the catalyst for the metamorphosis of landscape, observing landscape as an amalgamation of perception and perspective, and approaching it as one entity, image, or text (Duncan & Duncan, 1988; Cosgroves & Daniels, 1988). This approach requires considering not only the physicality of what they can see in front of them, but to also interrogate the various meanings and representations from within those spaces and construct new knowledges about society and place. As an interpretive form, I argue that landscape is made up of three distinct factions: the visual, the veil and the representation (Wylie, 2007). The visual refers explicitly to how landscape is observed by the human eye as a visual space defined by perspective. The veil is a metaphor for the subjective layer that exists between the individual and the landscape, a composition of thoughts, beliefs, perceptions, experiences, and emotions which have the potential to symbolise various cultures. The representational aspect is the materiality of landscape to present factors of significance, symbolic value, aesthetic notions, and the symbolic. Each part of the conceptualisation offers a different lens through which to investigate landscape.

I begin with the visual conceptualisation of landscape and query how people observe landscape and formulate a variety of opinions, responses, and behaviours to place. I discuss historical and heritage landscapes specifically, to better understand Sauer's considerations for a cultural landscape (Wylie, 2007). Secondly, I explore the veil of subjectivity, compiled of description, meaning, emotion and value that individuals subconsciously apply to landscape. I refer to cultural heritage sites as the primary landscape example, to consider how individuals may form connections and/or bonds with places in response to surrounding environments. It is this layer of detail that the research considers how best to record and capture, with my approach seeking to categorise this layer of information into key themes for further analysis. Finally, I assess the binary that landscape can be both a physical object of observation and interpretation, and a process that can persuade people's perception. I observe Wylie's (2007) representational connotations of landscape and observe landscape preference as a key contributing component of perception, that can sway and persuade individual's responses and reactions to landscape. I will link each aspect of Wylie's (2007) tripartite conceptualisation further, to discuss methods of collating and mapping this information, to communicate geographical knowledges through spatial representation. I have used each specific faction as an overarching subtheme, to discuss how individuals experience landscape from a cultural heritage perspective and formulate bonds and relationships with places of cultural heritage significance.

2.4.1 Visual Space and Human Observation

‘Landscape is an object of perception’ (Duncan & Duncan, 2010:225). It can be seen by the human eye through a window, a door and/or a camera lens, inclusive of wide expanses of space to identified sites of significance and areas of familiarity and meaning (Fowler, 2004). To understand cultural landscape, I first identify historic landscape as a term that recognises the significance of a place based on historical and cultural contexts (Yang, *et al.* 2016), i.e., a medieval city, ancient gardens, and historical market towns. It represents both human and cultural resource, preserved, shared, and experienced by others through a variety of mediums, including paintings, sculptures, and photographs, such as identity and aspects of history and art. Cultural resource is engrained within the function of the historic landscape, like a painting that communicates histories and previous cultural beliefs, or as physical sites that both preserve and educate those who wish to encounter those spaces. The second is heritage landscape which symbolise the history of specific groups of people, to enable the construction of an identity through physical representation (Braaksma, *et al.* 2016). It associates material representation through the collection of objects and artefacts deemed significant, and the meanings and values that people allocate to specific material features (Antrop, 2005; Smith 2006; Abu-Khafajah, 2010).

Fowler (2004) suggests that heritage landscapes encompass a degree of locality, that landscape will always mean something to someone regardless of either positive or negative perception. It suggests that Sauer was limited in his original interrogations of landscape because as a tension, landscape research can acknowledge the physicality and explore the immaterial and societal processes that exist both upon and within the landscape (Wylie, 2007). For example, cultural landscapes are more than just physical factors and spatially defined boundaries and spaces (Yang, *et al.* 2016). They are the reflection of culture and ongoing changes observed within the physical environment, encompassing both tangible and intangible factors (Fowler, 2004; Wylie, 2007; Yang, *et al.* 2016). Specifically, the World Heritage Centre embraces cultural landscapes as a concept and gives recognition to areas deemed to be of greater historical importance, cultural significance, and overall value. They appreciate the aesthetic, scientific, social, and historic values identified by society, and aim to protect areas that contribute to cultural identity for future generations to also experience, enjoy and learn from (Fowler, 2004; Vecco, 2010; Reynard & Giusti, 2018). However, cultural landscapes, objects and artefacts should not be restricted to specific guidelines and criteria. Cultural heritage should act as a stimulus and prompt reaction from communities,

researchers, and individuals, to recognise the value of heritage evident within the landscape (Wylie, 2007; Vecco, 2010). Landscape can both persuade and present a variety of historical and cultural factors, contributing to the construction of place identity, attachment, and sense of place.

As a physical form, landscape encompasses ideology with meaning hidden beneath layers of context, detail, and description, for deciphering quite like a piece of English literature (Duncan & Duncan, 1988; 2010). From a textual approach, it allows individuals and researchers to observe various community narratives and traditions and define visual space by perception based on the representations held and symbolised within landscapes (Duncan & Duncan, 2001). As part of a representational approach, landscape can also represent text through the physical features and/or markers observed within geographic space (Belletani, 2016), such as population demographics, religion, and culture. It can be used to investigate the symbolic associations that human agency allocates to landscapes, by deciphering associated meaning, perception, and societal attitudes (Rossetti, *et al.* 2019). Consequently, landscape becomes a visual representation of the actions of society based on evidence of textualised behaviours (Duncan & Duncan, 2010). On the other hand, landscape can also be interpreted as a form of image or artwork, where interpretations tend to be more symbolic by nature (Duncan & Duncan, 1988; 2010). This idea touches upon themes of art history, art culture, and genres of painting, sculpture, and architecture as a medium for representing landscape³³; that there is more to what people can see from within that metaphorical frame (Thrift, 2008; Howard, 2011). Associating non-representational theory, space is not held within the confines of a box, receptacle or vessel and can be created by the movements and performance of human agency within their corresponding environments (Thrift, 2008; Prince, 2018). Instead, landscape becomes a product of reaction, societal processes, and experience, as well as the engrained representations of culture and history that directly relate to the surrounding communities.

From a phenomenological viewpoint, landscape experiences encompass the perception of objects, the position of interpretation (whether on the ground, or through aerial perspectives), the ability to grasp the meaning engrained within landscape and its objects and, the cultural associations of the people within those communities and societies (Viik, 2011). These create

³³ To clarify, I will not be discussing landscape regarding art, history, and culture. I refer specifically to the visual space that people observe from various locations around an environment, and the interpretations that individuals formulate in response to what they can see.

spatial formations, where areas of defined space, environment and territory are assigned degrees of meaning, using physical features to make sense of their surroundings. Thus, physical components can also persuade perception whether these are artificially created landscapes, naturally occurring, or managed by human intervention (Ewing & Handy, 2009; Harvey & Aultman-Hall, 2016). Through a cultural landscape approach, features can represent more than just their purpose/function, as various architectures and buildings can symbolise a society's relationship to surrounding environments. Individuals subconsciously look for icons or symbols within the landscape to associate feeling, meaning, and understanding, finding representation within identified environments (Appleton, 1996; Wylie, 2007; Vecco, 2010). Whether false or incorrect, these features can represent several meanings and perceptions, through aspects of symbolisation.

Landscape features on one hand, are useful spatial reference points and allow individuals to direct themselves and others around identified places. On the other, they also have further qualitative connotations if people look beyond the surface representation. For example, Ordnance Survey maps or atlases use the cross symbol to pinpoint church locations, but the church itself may mean different things to different people. Landscape markers are a product of human response and reaction, that Hoskins suggests are engrained within the history of a place, whilst also serving a more practical function as a symbol of locality. Lynch (1960) describes landmarks as fingerprints of place that characterise and contribute to the formulation of place identity, such as giving directions to a passer-by and using key landscape features to create 'mental spatial models' (Zhou, *et al.* 2017:47). They are often used by individuals who are unfamiliar to an area, to help orientate themselves and acquire the knowledge to navigate landscape they have rarely, or never seen before (Zhou, *et al.* 2017). It is therefore common for individuals to symbolise features and manifest their own meanings about points on the land, that others may not have the context nor positionality to access (Appleton, 1996). All perceptions and perspectives are therefore unique, dependent upon the individual, and fascinating within their own right.

Landscape is therefore a palimpsest (Muir, 1998; Duncan & Duncan, 2010). Under constant scrutiny, it is more than just an aesthetical 'interest', it is a collective 'repository' of history (Muir, 1998:81). In this thesis, I understand landscape to have a series of layers like rock strata, which collectively create the foundations for individuals to relate and associate to. Looking closely at what is evident on the surface, I can metaphorically peel back layers of detail to discover more about specific areas and environments, and find evidence of pre-

existing heritage, cultures, and histories (Duncan & Duncan, 2010). In line with more poststructuralist thinkers, I consider landscape to be a series of ‘cultural productions’ that can be interrogated and assessed for meaning, power, social factors, and potential contradictions between the various histories and details within cultural landscapes (Duncan & Duncan, 2010:230). I can use symbolic representations and visual guides to decipher the landscape and consider the influence of human agency through reaction, response, aesthetic values, and behaviours (Thrift, 2008; Howard, 2011; Belletani, 2016; Prince, 2018). For landscape specifically, there is more to visual space than just the layers of context, history, and culture. Landscape can also be a way of seeing things, observing identified space and the level of engagement between people and place (Duncan & Duncan, 2010). Consequently, to observe landscape and decipher the visual space effectively, it requires an interpretative approach that acknowledges the positionality and values held by the observer, to understand the perception formulated (Yang, *et al.* 2016).

2.4.2 The Landscape Veil

The subjective veil exists both upon and within the layers that Hoskins describes as evidence of human response and reaction (Wylie, 2007; Thrift, 2008; Howard, 2011). It is a layer of qualitative detail composed of thoughts, beliefs, and perceptions that I will discuss in my examination of cultural heritage landscapes, to consider how individuals form connections and/or relationships with locations deemed of historical importance and cultural significance. I will identify and explore specific landscape themes as part of this research, contemplating how to record this information for representation as it is this data that will be used to create new forms of data visualisation and digital cartography.

Cultural heritage landscapes are areas that society and key organisations (i.e., UNESCO) have recognised as having special values, cultural significance, and historical importance (Wylie, 2007; Vecco, 2010). Alongside symbolic landscapes, they represent history, culture, and reflect the heritage engrained within landscapes. They are ideal for considering how landmarks and monuments may prompt and persuade perception, by exploring interpretations and responses to identified landscapes. However, historic landscapes are continually changing, whether gradually or very rapidly (Yang, *et al.* 2016). Layers of history and context are susceptible to loss due to developments by human agency in response to changes occurring both in and around environments, such as the quickening technological advancements and greater pressures to meet the demands of the population.

Subsequently, relationships with place are dynamic and can adapt and reflex, contributing to a more complex construction of identity (Manzo, 2003). Landscape identity specifically is the 'perceived uniqueness of a place' that results from personal and social constructs and is not necessarily constricted to the physical features of a specific area or geographical boundaries (Stobbelaar & Pedroli, 2011:322). It can be persuaded by considerations from the past, the present, and the future, portrayed through various symbols and representations in the landscape, including architecture, historical monuments, and redevelopment. Hoskins suggested that landscape is primarily an object of perception, however I argue that these landscape markers represent and symbolise the physical, natural, culture, and experience. They are more than catalysts for response or symbols of the intangible, whereby landscape perception is derived from 'inseparable' themes of landscape and place (Soini, *et al.* 2012:125). In this case, 'landscape is like a book' that individuals read whilst looking through the veil to interpret the subjectivity of landscape (Wylie, 2007:70).

Sense of place is used to describe and understand the deep connections that people associate to place, based on people's experiences and the attention, meanings, and emotions that individuals invest in place (Shamsuddin & Ujang, 2008; Soini, *et al.* 2012). It is a multifaceted concept that I have identified as a key theme in the interpretation of cultural heritage landscapes. Using Soini, *et al.* (2012), I have deconstructed and expanded upon five components of sense of place to consider how each contributes towards the subjective layer of thoughts, beliefs, perceptions, and experience. These are attachment to place³⁴, social relations, adaptability of use, landscape appreciation and landscape satisfaction. The following critical engagement provides the guidelines and framework to consider how best to investigate and record each of the components deemed relevant this research investigation (Soini, *et al.* 2012).

- Attachment to Place

This concept is comprised of affect, cognition and practice that enables individuals to develop meanings and perceptions of environments (Shamsuddin & Ujang, 2008; Ram, *et al.* 2016). It is devised from attachment theory and associates the level of trust individuals hold to an area derived from experiences, behaviours and attitudes that occurred in early childhood (Ram, *et al.* 2016). It is the emotional investment and connections that individual formulate with locations, having experienced these places either on numerous occasions or at first visit (Kyle, *et al.* 2004; Shamsuddin & Ujang, 2008). Additionally, attachment to place is derived from

³⁴ Attachment to place is also known as place attachment. For clarity and consistency, I will refer to this concept as attachment to place throughout.

the environmental, societal qualities and characteristics, which meet the individual's expectations and requirements (Shamsuddin & Ujang, 2008). Hypothetically speaking, the better a location can do this, the higher it ranks in perception, therefore contributing to a personalised landscape identity. It is affected little by developments and changes in cases where individuals have never visited locations before (Ram, *et al.* 2016). To investigate and collate this detail requires observing environments and the responses of people within those spaces, as well as enquiring about people's thoughts and feelings to specific areas.

- Social Relations

Based on the connections within the communities of landscapes, social relations can determine the strength of these links, resulting in various degrees of attachment (Soini, *et al.* 2012). For example, Stedman (2006) found that permanent, long-term residents who had social relations within a place, tended to acknowledge these as contributing factors towards sense of place. Those people who lived in an area for the short-term, such as secondary homes, tended to associate environmental qualities as the contributing factor to sense of place. For this research, the varying degrees of attachment by social relation links to the individual's purpose and experience. Using Stedman's (2006) hypothesis that the longer a person is situated within a space, the greater the attachment through social relations, I can investigate and query the reasons for people's presence within cultural heritage landscapes, and the purpose of their time at locations. By collecting qualitative details and accounts, I can see how activities and relations may differ in terms of a person's positionality and motive, in response to their surrounding environment.

- Adaptability of Use

This refers to the changes that individuals make to their everyday lives, and by extension, their personal societal practices to better situate themselves within landscapes. Developments and alterations could suggest variations in the levels of attachment and satisfaction, such as the removal of historical monuments³⁵ that represent a darker, more negative past, causing mixed responses regarding the perceived meanings and associations. It is an important factor to consider because for those who do feel change is needed, these individuals may have a weaker relationship to place, therefore constructing a weaker sense of place (Manzo, 2003; Soini, *et al.* 2012). This suggests that the physical environment does contribute meaning to the metaphorical veil, because there is a degree of management needed to invest both mentally and physically with landscapes.

- Landscape Appreciation

³⁵ See Forest & Johnson (2018) regarding 'Confederate monuments and the problem of forgetting', or the more recent events of June 2020 regarding the toppling of the Edward Colston statue (Grey, 2020).

Landscape appreciation incorporates the intangible and considers a more ‘artistic conception’ that observes aesthetic quality as a key principle (Yang, *et al.* 2016:111). Similarly, to an image, it considers how societal practices and cultural context are symbolised and represented through environmental and aesthetical qualities, alongside landscape markers (Wylie, 2007; Howard, 2011). It regards not only the theoretical understandings but also the practical and physical associations of identified environments. Aesthetics are a way of indicating the intangible values represented both upon and within the landscape, however landscape can become the focus of appreciation rather than the focus for evaluation. To do so, I require a mixed methodology to clarify this distinction, tailoring the methods to collect both primary and secondary sources of data relating to people’s evaluations of place. I can then search for evidence relating to specific categories of themes from within the subjective veil (Makino, 2018).

- Landscape Satisfaction

Satisfaction on the other hand, lends itself towards the tangible. It is derived from understanding how environments can meet the needs and requirements of individuals based primarily on the physical qualities (Soini, *et al.* 2012; Ramkissoon, 2016), such as providing services and amenities that enable communities to function and survive within specific places. Human behaviour can better predict landscape satisfaction by observing societal activities within place, assessing the physical reactions and responses to environments through potential motivations and acted-out agendas of individuals at sites (i.e., residents out shopping, people visiting landmarks and monuments). Supposedly, an increased level of satisfaction can increase identity and social bonding, whereby it has a positive effect on place attachment and by extension sense of place (Ramkissoon & Mavondo, 2015; Ramkissoon, 2016). Though landscape satisfaction is less symbolic and meaningful than the principles associated to attachment, it does provide a degree of judgement about space as an object (Stedman, 2002, 2006). Researchers must therefore understand the social contexts of the relationship between people and place to use satisfaction as an indicator of landscape evaluation. The recorded attitudes, behaviours, and beliefs all contribute towards cognition and the subsequent provision of meaning.

By identifying key place components, I can frame and tailor the methodology to collate evidence from within the metaphorical veil, strategically incorporating a spatial quality to the datasets (Soini, *et al.* 2012; Brown, *et al.* 2015). The data collection methods need to categorise information into key themes for processing to facilitate digitisation and manipulation and enable the subsequent transformation of data into representations and

cartographic forms. For example, face-to-face interviews can collect rich qualitative details and description from primary sources (Shamsuddin & Ujang 2008), questionnaires can collect both quantitative and qualitative detail using a variety of question types (Stedman, 2002; Kyle, *et al.* 2004; Ram, *et al.* 2016), and field surveys and participant observations enable notetaking and interpretation of space themselves, whilst observing behaviours and reactions in situ (Yang, *et al.* 2016). However, I will not go into detail here. I will divulge the research methodology in the following chapter.

2.4.3 Representation and Communication

The third and final section discusses how landscape can represent history, culture, and other forms of knowledges as a tension, being both a) a material object/ physical thing upon which researchers can base their research and observations, and b) a process that can persuade perception through cultural significance, societal attitudes, and other holistic approaches.

Landscape can be both looked upon but also inhabited where Sauer and Hoskins both acknowledged that landscape had to be discovered, experienced, touched and therefore lived in, to observe it from a detached view. However, diction dictates direction. Landscape can be viewed, scrutinised, and deciphered from a specific point or perspective, and is observed in the eye of the beholder. Referring to the representational context, landscape is a means for communicating through visual representation, symbols, markers, and other symbolic associations (Wylie, 2007). The recognition of societal value, cultural significance and historical importance ingrained at cultural heritage landscapes provides the context to investigate complex symbolic landscapes (Yang, *et al.* 2016), providing the opportunity to interrogate and decipher meanings hidden within the landscape layers (Belletani, 2016). As a text, Carrabine (2018:447) acknowledges a similar approach to Duncan & Duncan (2010), though argues landscape is ‘authored’ and ‘orchestrated’ to present the experiences and relationships that encompass society and way of life. It suggests that the perceptions presented within landscape may be tailored and selectively deciphered by individuals, in relation to their milieu, positionality, personality and experiences. Thus, landscape is a medium for thinking about the relationships between people and place, considering what Jackson terms a vernacular landscape. Perception can be investigated by exploring key components and categories within landscape and observing the characteristics that subsequently fit into identified classes (Rechtman, 2013), such as the five sense of place components.

However, cultural heritage landscapes can be problematic in terms of identifying areas by locality and observing sense of place. Cultural heritage sites often become tourist-driven locations because of the financial support and opportunities available, to educate and raise awareness of their importance and significance (Vecco, 2010; Yang, *et al.* 2016). It can subsequently restrict and persuade the vernacular because it is difficult to isolate tourism as a specific landscape category or theme; it is intertwined within the societal lives of the host community (Prince, 2018). Yet, this is not a limitation. It is possible to observe the intangible through the physicality of landscapes and use them as a focus, medium and/or lens. In this research investigation specifically, looking for evidence of each sense of place component can counter-act this issue by incorporating it into the research methods, using questionnaires to distinguish the purpose of individual's visits, the reasons for being present at specific cultural heritage sites and identifying how familiar they are with each unique landscape (i.e., resident, or first-time visitor).

In addition to perception, landscape preference is key to visually assessing landscape as different landscapes contain different series of stimuli that prompt responses and reaction (Sevenant & Antrop, 2011). Visual preferences can suggest some form of relationship to place by observing the physical features and markers that are found within the areas of interest, whilst considering what other factors may influence these perceived aesthetic qualities and attributes (Rechtman, 2013). Notably, resulting behaviours vary by individual and provide evidence relating to the process of persuasion caused by the representations within unique environments. Landscape representations are therefore a 'dynamic, cultural force' (Carrabine, 2018:448), providing provide the ideological and phenomenological understandings for investigating how landscape can influence people's responses, reactions, and behaviours towards specific places.

Throughout the discussion of landscape experience, these metaphorical layers have continuously appeared and been referenced to. Made up of historical context, cultural significance, societal processes and meaning, this research focuses on how best to record these details to evidence the strategies and techniques deployed to quantify the qualitative for creating data visualisations. The knowledges that appear from the analysis will contribute to emerging themes of perceived interpretations, these being the layers of meaning, experience, and performances that society places upon the landscape as part of the everyday. Researchers should consider the provision of mapping as an actual application to create cartographic representations and to visualise the bonds/connections between identified concepts and place

(Sevenant & Antrop, 2011). Exploratory studies have enquired about the how and why of landscape experience but less about the role that geographical space plays in the construction of sense of place and landscape interpretation (Williams, 2014; Brown, *et al.* 2015). Some research refers to scale and the differences between the local and the generic, but there is little about interrogating these concepts through forms of spatial representation and analysis (Cacciapaglia & Yung, 2010; Lin & Lockwood, 2014). Mapping can enable researchers to investigate these concepts further and is a motive I have embedded within this research, to further geographic enquiry and contribute context to those how and why questions (Brown, *et al.* 2015). The resulting representations can function as supplementary, exploratory and/or investigatory sources of information, by providing a more detailed understanding of the relationships between people and place.

Finally, I turn to Olwig (2017) to contemplate, whether landscape be mapped as either a cartographic representation, illustration, diagram, and/or chart, or is landscape a product of the map itself? Olwig (2017) suggests that maps are the initial pieces of context that studies use to investigate the societal processes between people and place. I therefore take the conceptualisation offered by Wylie (2007) to observe landscape not only as the physical representation of society's actions, but also the medium for communicating responses and reactions through forms of data representation. Capturing landscape within forms of cartography will allow the use of spatial context engrained within identified environments, to better associate the cultural significance and historical importance that characterise cultural heritage landscapes. Cartography is a means to present both naturally occurring and cultural phenomena, either independently or in tandem to one another as part of the same visualisation. Utilising it in this way, landscape is primarily a text to understand both the metaphorical and computational layers that individuals associate to landscapes. As an image, I can then understand the meanings, symbolisms, and other intangible qualities that landscape can encompass (Duncan & Duncan, 2010). Consequently, as a form of communication, landscape can be both the mapped representation, but also a physical representation of place.

2.5 Chapter Summary

Drawing this chapter to a close, cartography is a 'partial and contested set of practices and performances' (Del Casino & Hanna, 2006:51), and I confer that maps are always of a processual form, albeit in the constant process of production and consumption (see Kitchin and Dodge, 2007 and Kitchin, *et al.* 2013). In this paper, the literal use and application of a map is scrutinised through ethnographic and other qualitative methods that enable the

researcher to investigate the role that mapping practices can play alongside every day social experiences of place, specifically, identity and knowledge construction relating to tourism and identified historical locations. Del Casino & Hanna (2006) suggest that rather than enforce or fall prey to the binary of consumer/production, their reference to Barthes (1978) implies that the map author is in fact ‘dead’ and the (re)reading, (re)production of map spaces through the various performances by individuals within society (social actors) are based on the interactions between the user and the map. Maps are more than just representations of phenomena and objects of analyses, but instead are the ‘myriad interconnections that make the production and consumption of map spaces a process of both authoring and reading simultaneously’ (Del Casino & Hanna, 2006). This means that researchers need to be mindful of the various lenses, semantics, factors, and attributes that are associated to understanding maps and various cartographies and consider the more critical context to better understand their role.

GIS is a dominant key tool for presenting spatial relationships, being able to facilitate the explorations and representations of a variety of data through its technological capabilities and computational power (Knowles, *et al.* 2015). However, GIS is more than just a tool as it can prompt geographical thought and open avenues of enquiry, through its intersection with qualitative research. Qualitative GIS is a key approach to this research informing associated strategies to collect and present qualitative data (Elwood & Cope, 2009). Its core purpose to integrate multiple knowledges and findings from a variety of techniques provides a breadth of opportunities for researchers to combine methods through a mixed methods approach, using visualisation as an effective analytical technique for revealing spatial trends, patterns, and relationships within datasets. Through grounded visualisation, these data representations can assist researchers in investigating not just the ‘what’ and the ‘where’ but consider answers to the ‘why’ and ‘how’ (Knigge & Cope, 2006; Yau, 2011). In the context of landscape, these approaches will help researchers to understand the diverse and metaphorical layers of complex systems and subjectivity at cultural heritage locations, offering potential insights and explanations for the interactions and behaviours seen in various landscapes and settings.

In this thesis, data visualisation considers both cartographic representations and data graphics as part of a visualisation package, enabling users to make sense of data through associated tools and techniques (Yau, 2011; Lee, *et al.* 2015; Kirk, 2016). The provided history of mapping and cartography highlights key developments and contributions, showcasing some familiar and original works that underpin the familiar data graphics and cartographic

representations observed today. The emergence of digital cartography and electronic mapping has shown not only the complexities that emerged in response to increasingly available technology and online software/applications, but also the transition of cartography from more professional origins, to those where anyone with access to a computer and GIS can create a digital map. However, whilst the creation of new tools and applications have since been able to offer inexperienced users the opportunity to create representations of their own and encourage further engagement with digital cartography, they lack the necessary design principles that ensure a clear and effective form of data representation. Notably, visualising data draws on an extensive range of strategies and techniques that require an engagement with associated design principles to communicate information effectively.

Finally, I argue that the evidence, critiques, and discussions conversed within this chapter indicate that there is room for researchers to better understand landscape and people's interpretations of landscape. There are additional needs and opportunities for social scientists to acquire much stronger, more meaningful explanations and conclusions, by taking another step forward with their analysis and considering the possibilities and potential that data visualisation can provide. Data visualisations can present new knowledges by processing quantitative data through a form of GIS, but they can also integrate qualitative detail and description. From the cultural heritage lens, the motive of these representations is to visualise the complexities and describe the relationships between people and place, such as landscape perceptions themes in situ to spatial context (Robinson, *et al.* 1995; Phan, *et al.* 2005; Krygier & Wood, 2011). The problem that researchers have, however, is figuring out a way to associate the qualitative detail. Aitken & Kwan (2010) note that whilst researchers can already make qualitative data 'digital' by recording it in some form of computerised database, what else can be done with such datasets?

My investigation will now outline the research methodology and explore methods to record perceptions and experience, using tools to quantify qualitative data and consider how this information can be processed and presented in visual form.

Chapter 3.0 Approaching a Mixed Methodology

3.1 Mixed-Methods and Qualitative GIS

As a multifaceted approach, GIS specifically is more than a technological resource or limited to a form of computer software or system. It can help to achieve goals and accomplish tasks whilst aiding further enquiry (Pickles, 1997; Elwood, 2005). Through a mixed methodology, GIS can help to produce new meanings and interpretations through new forms of data representation, to facilitate more in-depth, more engaged discoveries within geographical sciences (Elwood & Cope, 2009). Being mindful of the research aim, to develop techniques for quantifying qualitative detail requires using GIS beyond methods of quantification to encompass aspects of ethnographic study (Kwan, 2002a). Qualitative GIS³⁶ is specific to the spatial sciences due to the implementation of data collection, analytical, and representational processes, each of which facilitate a more in-depth understanding of social, geographic phenomenon across space. By drawing on previous discussions, I have used qualitative GIS as an inclusive mixed methods approach for knowledge production and communication (Knigge & Cope, 2006; Elwood & Cope, 2009). I have developed an approach that can integrate a variety of data types collected using a series of data collection methods, to design cartographic representations capable of presenting both qualitative and quantitative data across various spatial scales (Goodchild, 1995; Elwood & Cope, 2009). This has enabled the production of new geographical knowledges through data visualisation (Elwood & Cope, 2009; Aitken & Kwan, 2010), enabling my work to contribute to a wider body of research. Thus, I emphasise that my work is experimental and there will be limitations that I will address and reflect on later.

To do so, this chapter outlines the methodology and how I have been able to associate qualitative detail with spatial data; outlining how this study has integrated GIS with a variety of qualitative data types, methods, and sources (Aitken & Kwan, 2010). It explores new techniques and strategies for quantifying qualitative data to produce data representations purposely designed for communicating landscape perception. The chapter begins by introducing my approach to the research investigation, designed to be completed in two specific stages; the first being the development of tools and techniques for data collection; the second being the testing of various data visualisations for constructing new cartographic representations. This chapter will then outline each of the research methods highlighting their

³⁶ See Chapter 2.0, section 2.2.2 Qualitative GIS

aim to provide some form of count or measure, either through collection, digitisation, or analytical processes. I will provide an outline and justification of each of the three research locations used as a basis for the research investigation, and the corresponding collection strategy implemented at each site. I move further to acknowledge the data manipulation and analytical processes used to facilitate the resulting representations, discussing more specifically my approaches to coding and the collaboration of key social science software (i.e., NVIVO) to GIS. I finish by acknowledging the ethical implications and risk assessment necessary for undertaking this research, to adhere to the institutions Code of Good Practice and Ethics Policy.

3.2 The Approach

This research investigates people's perception of landscape with a focus on interpretations and responses to cultural heritage sites. It considers the conceptualisation of landscape and theories of representation (Wylie, 2007; Duncan & Duncan, 2010; Reynard & Giusti, 2018), to examine methods for capturing and recording landscape perception. In the devising of a mixed methodology, this thesis uses innovative applications of GIS to map interpretations and responses to specific heritage landscapes. Concurrently, the research will develop tools and techniques to analyse and present responses to landscape through forms of digital cartography. The methodology was carried out at three research locations across County Durham, to provide different visual contexts for data representations. These were Esh Winning in County Durham, which is a former colliery village that provides a rural, ex-industrial context; Stanhope, Weardale, is a small market town and Area of Outstanding Natural Beauty, providing a rural landscape for evaluation; Durham Peninsula (Castle and Cathedral), Durham City, is an area of sensitive conservation and inscribed on the World Heritage list. The mixed methodology was replicated three times to provide a temporal quality to the datasets, providing the potential to cartographically represent and observe patterns between different time periods (October 2016, February 2017, July 2017).

3.2.1 The Two-Stage Approach

The mixed methods approach was designed and completed in two separate stages:

- 1) The first stage focused on developing tools for collecting both quantitative and qualitative data through categorical and quantifiable means. This included developing questionnaires, audit surveys, participant observations, and semi-structured interviews, capable of quantifying participant's responses to landscape, their perceptions, behaviours, emotions, and opinions. Subsequently, the data collection methods

provided some form of count and/or measure, to enable the computational processing of collated information.

- 2) The second stage involved creating various data representations, designed to visually communicate the relationships between individuals and their perceptions of landscape. This required incorporating secondary data for both background content and familiarisation (i.e., ordnance survey and census data), to observe key spatial factors that may have contributed to the formulation of participant perceptions (i.e., landmarks, monuments, land use, and so on). This involved examining a range of data visualisation techniques, critiquing their use, and investigating how each could facilitate the representation of qualitative information, before creating data visualisations that present and communicate people's interpretations of heritage landscapes. These were designed with cartographic representation at the forefront of the research specification.

The focus of the investigation was to enable both myself and other researchers to use more innovative approaches to research, to examine how individuals form connections with historically significant, cultural heritage landscapes. The resulting data representations were used to explore the bonds and relationships between people and place at each of the three research locations, to investigate potential evidence of landscape themes specifically relating to sense of place³⁷ (Soini, *et al.* 2012). The following section outlines the identified data collection methods to do so and the adaptations required for the thesis.

3.3 Research Methods

The investigation has encompassed both qualitative and quantitative research, with the resulting methods combining description and observations required from qualitative data types, with the numerical formats and secondary census sources from quantitative records (Elliot & Timulak, 2005). These include the following:

3.3.1 Participant Observations

For this research project there was a need to watch and describe the activities of individuals from within a variety of settings and environments; observing the behaviours, interactions, responses, and exchanges between people from within a natural setting (Kawulich, 2005). It

³⁷ See Chapter 2.0, section 2.4.2 The Landscape Veil regarding sense of place as a multifaceted concept

required completing observations through a combination of notes, photographs, and field sketches, whilst remaining detached from my subject group and looking in on environments (Erlandson, *et al.* 1993; DeWalt & DeWalt, 2010). Known as ‘covert’ ethnographies, within each research location I did not disclose to my target population group what I was doing, removing the need for permissions and access to specific environments and settings (Bryman, 2016). It increased the likelihood of respondents to act more naturally within environments, rather than tailoring their attitudes and behaviours towards me as the observer (Zahle, 2012; Bryman, 2016).

The purpose of the participant observations were to observe, note and record the behaviours and interactions of individuals, in accordance to a set of guidelines that were loosely applied to conducting observations. Conducted at specific points around each research location³⁸, rather than try to collect as much detail and information about the actions and behaviours unfolding in front of me, I devised a strategy to make better use of my time and explore topics relevant to the thesis (Kawulich, 2005; Watson & Till, 2010). This ensured some flexibility, so that events, behaviours and interactions were recorded as they unfolded with relevant details. By applying a minimal level of structure, it ensured the data could be easily categorised and analysed through specific software, but still provide the necessary context and detail to suggest why these events were happening (Punch, 2005). These categories included, and were not limited, to the following;

³⁸ More details regarding identified data collection points are explained further in section 3.5.

Category	Question	Recorded Information
Location	Where are the observations taking place?	Time, Date, Location
Environmental	Consider external factors and influences in the area. Are there any key features, landmarks, and monuments present? Is there any evidence of management and maintenance? What are the main land use functions?	Weather, Landscape (urban vs rural) Examples: physical topography (i.e., rivers, open moorlands), cathedrals, churches, war memorials, etc. Management; Evidence of restoration/work, access features (i.e., steppingstones).
Demographics	Who is there in the area? What age ranges are they, and gender? Are there any specific characteristics that stand out to the observer?	Age, Gender, Groups of People (i.e., families vs. couples). Additional detail may include clothing, animals (i.e., dogs), carrying shopping bags, prams etc.
Purpose	What are people doing? Is it possible to suggest reasons for their presence? How?	Day Out, Sight-seeing, Work, Leisure and Recreation, Education (i.e., University students) etc.
Atmosphere	How does the area ‘ feel’ ? Is there a positive/negative atmosphere? What sort of emotions/feelings are apparent regarding the people in the area?	Description; looming clouds creating an ominous feel, the sunshine creating a bright, picturesque environment, etc. Emotion: happiness, relaxed, peaceful, alive with activity, etc.
Interactions and Behaviours	What are people doing in the area? Is there evidence of ‘ meet-and-greet? Are people stopping to engage in conversation? If so by whom, and what about?	Tasks; Shopping, eating lunch, working, dog-walking, etc. Examples: people stopping to say hello to another, asking for directions. Listen for key words in conversation (where possible).

Table 1: Observation Agenda and Considerations

I acknowledged the risk of my observations having little relevance towards the investigation, which is often caused by failing to stick to the research agenda in keeping with the scope of research (Zahle, 2012). By drawing up a series of guidelines to combat this issue, it provided an indication of the broad categories of information required for collection to minimise this risk. It was a helpful guide to ensure that I could carry out my observations and use the agenda to frame my understandings of events and activities. Furthermore, through a covert strategy, I ensured there was minimal risk of manipulation or influence on the behaviours of individuals being observed (Punch, 2005; Bryman, 2016). I played a 'passive' role and did not get involved nor participate in any of the events and situations unfolding (Bryman, 2016:438). There were however, other methods following the completion of the participant observations that required asking questions and conducting informal conversations to gather additional detail and information (i.e. questionnaires and semi-structured interviews). Accordingly, the observations were conducted first at each research location to minimise the risk of influence and stimulation of participant behaviours. I conducted five participant observations at Esh Winning, nine at Stanhope and eight at Durham, and replicated the method at the same locations during each data collection phase (October, 2016, February 2017 and June 2017).

Participant observation comes with a variety of limitations and restrictions that were my responsibility to ensure had as little impact as possible upon the data collection and analysis process. This included issues of misinterpretation, and/or missing out necessary detail from the recordings and notations, though it is impossible to record every detail and observation (Kawulich, 2005). For this investigation, I tried to reduce these implications by taking photographs at each of the research locations to use as both a reflective visual reminder and supplementary tool to support the interpretations and recordings made (Watson & Till, 2010). Collected at specific points around each of the three research locations, I was able to note key characteristics and differences between each of the locations visited, for comparison at either a generic scale by location, or at specific points in/around the research locations on a more microscale. Repetition of the method at three different time periods also facilitated temporal comparisons, using the photographs as an additional tool for visual comparison. Once all the data was collected and analysed, the results were combined and cross-referenced with the other data collection methods to either validate or disprove my observations (Watson & Till, 2010). By combining more than one method together in this way, the methodology provides further evidence of the suitability of a mixed-methods approach, considering its capabilities as a flexible, creative and integrative approach (Gregory, *et al.* 2009).

In this investigation, the observational aspect considered how people use and interact within specific locations and places (Bryman, 2016), whilst the participatory part referred to the actions made to identify and observe participants in various locations and circumstances (Zahle, 2012). There was less emphasis on the immersion of the researcher and instead a clear focus on recording evidence of relationships with heritage landscapes. Though my participant observations were completed with loose guidelines and planning, this method still allowed for the collection of rich detail using the categories observed in Table 1, to classify the behaviours, perceptions, and responses to cultural heritage sites (Punch, 2005; Kawulich, 2005; Watson & Till, 2010).

3.3.2 Audit Surveys

‘Audits’ are a tool that allow researchers to record observations of their surroundings directly from their on-site, in-location positions, based on specific themes or variables that are relevant to their research (Southworth, 2003; Harvey & Aultman, 2016). They are a method of collecting both quantitative and qualitative data using specific question formats, recording information about the reactions and responses of individuals within a variety of environments and settings. To utilise this method effectively, I observed two examples of an audit survey, the ‘Analytic Audit Tool’ and ‘Checklist Audit Tool’, each designed to investigate relationships between built environments and physical activity (Brownson, *et al.* 2003). The analytical version is constructed using questions with continuum scales for ordinal responses and the checklist tool consists of questions that warrant a more dichotomous response. I also looked at a third, the ‘Irvine Minnesota Inventory’, which is designed to collect data to assess how the built environment may influence society’s physical activity levels (Day, *et al.* 2005; Day, *et al.* 2006). I noted two limitations regarding these examples. They were not designed for more rural contexts, nor to collect qualitative data about heritage landscapes and perception. This meant that the audit survey required for this research had to be redrafted, developed, and tailored using ideas from Brownson, *et al.* (2003), Day, *et al.* (2005), and Day *et al.* (2006), to create an audit suitable for this research and for use at each location. My focus therefore was to devise an audit rubric that could be used in the future to map rural-based physical environments.

The research needed an audit survey that could record direct observations of landscape, whilst also quantifying and pinpointing variables that may be associated to those observations (Harvey & Aultman-Hall, 2016). However, audit surveys rely on both numerical data

collection for statistical analysis, and linguistic associations, whereby meanings/emotions are measured and recorded using numerical figures (Polkinghorne 1983, cited by Elliot & Timulak, 2005). Specifically, I needed closed-ended questions to record observations in a quantifiable format, and open-ended questions to collect any additional detail and description, relating to my perceptions of each research site. However, some qualitative attributes are still not easily measured and quantified, so I had to consider which details I needed and how to categorise and sort this information from my recordings (Ewing & Handy, 2009; Lee & Talen, 2014). The criteria and categories were specified using Brownson, *et al.* (2009:100) and Pikora, *et al.* (2002:190-193), identifying key sub-categories for assessing landscapes at each location. These needed to collect information regarding a series of themes and concepts that linked directly to the study³⁹, through aspects of functionality, aesthetic qualities, destination facilities, and other forms of subjective assessment including perceived attractiveness. I also considered access to the sites, public spaces, activity, and aesthetic qualities regarding visual access to the views and surrounding landscape (Southworth, 2003).

Observing Appendix A, the audit survey was structured into themes of information, each with a series of sub-categories and corresponding questions and question types to quantify data. It did not make the collated information a 'validated list of relevant measures', but instead a categorised list of observations, visual interpretations, and hand-written recordings relative to the research (Harvey & Aultman-Hall, 2016:151). Appendix A was created to collate evidence of; a variety of land uses (i.e., commercial and residential); various types of natural features (i.e., bodies of water and hills), facilities and service amenities in the area (i.e., car parking and public toilets); a range of aesthetic and sensory attributes (such as visual outlook and pollutants); and a social environment (such as who may be interacting within the area, and how). Each category consists of specific questions that collect information about the area at that specific point in time, recorded using a series of question formats including tick-boxes for single and multiple-choice answers, continuum scales, open-ended questions, and a comment box at the end for noting additional detail, description, and clarifications. As the Brownson, *et al.* (2003) and Day, *et al.* (2005) examples contained other context specific to their own work, I too was selective. I did not include queries regarding specific forms of transport, traffic features, or bicycle access because it was not relevant. Once validated for suitability for both in-person collection and digitisation, the survey was piloted, a final draft

³⁹ See Chapter 2.0, section 2.4.2 The Landscape Veil regarding the five sense of place components: attachment to place, social relations, adaptability of use, landscape appreciation, and landscape satisfaction.

put together, and the collection process began (Lee & Talen, 2014). Further information is provided later, regarding the piloting process.

The audit surveys were able to collect description and detail from in-person observations with other secondary sources, such as Google Street View, being used to supplement the information, providing greater potential for detailed data sets and observations. These are however, limited in terms of reliability and accuracy (Lee & Talen, 2014). Specifically, I had issues associated to the date of satellite imagery and ordnance survey files, whereby older files did not show the most up-to-date and accurate representations of place, area coverage where some sources did not have data presenting my research areas, nor provide enough detailed imagery, the availability of data where some resources and websites charged additional fees to download their datasets, and the format of the files where I had to spend time transforming files into usable formats. On the other hand, through GIS, the quantitative assessments (such as land use, census data, and boundary information) were visualised alongside subjective records, further supported by photographs taken at each location and corresponding to each of the completed audit surveys (Lee & Talen, 2014). These images allowed me to reflect on the environments where the surveys were completed, using them as visual prompts to recollect various details, i.e., land use, landmarks and so on.

Though audits are highly suitable for subjective investigations, one of the biggest limitations is the cost to do so (Lee & Talen, 2014), whether in terms of time to complete all specified research areas, or to train individuals on audit data collection strategies. Thankfully, this research did not require additional training to carry out the method, however, I found limited guidance regarding the quantity of audits needed to successfully support my investigation and strengthen the validity of both the data and its conclusions. Brownson, *et al.* (2009) found that when they observed twenty methodologies as part of their own work, some investigations included up to ten detailed audits, whilst others had collected well over 100. They suggested that by collecting more audits, it would be possible to cross-reference the data and acquire a more reliable, in-depth, and detailed database, though it is not always feasible to do so (Brownson, *et al.* 2009). For this research investigation, I compromised and identified areas of interest and relevance across each location (Schlossberg, *et al.* 2007). More specifically, there were a varied number of audits completed at each of the three research locations; Esh Winning had five audits conducted, Stanhope had nine, and Durham had eight, as each location differed in size and scale. These were completed in a strategic and systematic manner to ensure the areas and subsequent records did not overlap nor record the same information. I

made sure that the study collected information from a variety of unique environments across each of the three differently sized research areas, whilst mindful that collecting information away from the main cultural heritage sites would not provide information relating to people's responses to stimuli within each environment (Mehta, 2008; Ewing & Handy, 2009). Once the audits and other methods were completed, the data collated from the audit surveys was digitised and manipulated through GIS, as explored later in Chapter 4.

3.3.3 Questionnaires

Questionnaires (or surveys) are a common method of data collection due to their capability to collect both quantitative and qualitative data using a series of open and closed question types (Parfitt, 2005; Bryman, 2016). Exploratory questionnaires primarily collect qualitative information using open-ended questions, like comment boxes or outlined spaces.

Questionnaires aimed at more descriptive forms of research are designed using a series of closed questions like tick-boxes, and/or multiple choice, to collect quantitative information usually for statistical analysis (Parfitt, 2005; Remenyi, 2011). My research specifically acknowledged both types of questionnaire, to collect qualitative detail about people's perceptions and opinions in more manageable, quantifiable ways. I took the key characteristics of both and used comment boxes and tick-boxes to create a suitable tailor-made survey.

For this investigation, the questionnaire needed to encompass three key functions and aims. The first was to classify people into specific groups (i.e., age, gender, visitation purpose, and/or even frequency of visits) to facilitate the data manipulation and representational process and observe relationships between specific variables (i.e., age versus the reasons for visiting). The second motive was to record details about the behaviour of individuals, such as how often have they visited a specific heritage site, where have they travelled from to visit, and the types of interactions they had with specific cultural, heritage sites. The third function was to describe the attitudes and opinions of participants, referring specifically to the perceptions and interpretations that participants formulate as a response to having visited certain sites. Doing so allowed me to suggest reasons for their actions within certain places and understand their emotional responses to the landscape (Bryman, 2016), i.e., do they feel a connection to the space, and have they enjoyed their visit?

Appendix B uses tick-box and multiple-choice selections to quantify the number of responses per selected answer, open-ended questions to enable participants to provide further details and

context, where supplied tick-box answers may not have been suitable, and continuum scales to measure people's responses to specific stimuli along a numerical scale. The questionnaire also includes purposely framed, open-ended questions that required participants to think about their perceptions and initial reactions to their surroundings, identifying three key words that they would associate to their interpretations. These provided specific descriptive terms about each corresponding research area and were used to create/supplement one of the newly designed forms of data visualisation explored later in the thesis. The continuum scales are referred to as Likert Scales and are an example of how to collect qualitative information in a quantitative manner, combining the properties of both exploratory and descriptive questionnaires. I wish to elaborate further on this type of question format, to signpost key information for understanding a newly developed map observed later⁴⁰.

Originally designed by Rensis Likert in the 1930's (Hartley, 2014), Likert scales or continuum scales are a common method for measuring people's opinions, perceptions, and attitudes towards various topics, themes and ideas. They were incorporated to collect qualitative detail and provide a measure of count, whereby participants were required to fill out measurement scales to indicate their responses to specific objects/statements (Hartley, 2014). They can aggregate individuals' opinions using rating scales to measure the attitudes and perceptions towards an idea or opinion, consequently producing a representative value for each question (Harpe, 2015). For example, these were included in variations of, 'on a scale of one to five, to what extent do you agree with the following statement...?' and, 'how important do you think it is to...?' The examples below have been taken from Appendix B, outlining how these question types were utilised within the data collection process. Though there was a danger that the statements were both misleading and suggestive to the participant, I needed participants to be able to identify and relate to specific themes and concepts, using provided scales as a point of measure (Parfitt, 2005):

⁴⁰ In Chapter 6, section 6.4. Qualitative Cartography

Example 1:

To what extent do you agree with the following statements?

Please indicate just ONE column of agreement per statement:

Attachment to Place

a) I feel a personal connection to (PLACE NAME) and its settings and services.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5

Example 2:

On a scale of 1 (not at all important) to 5 (very important), how important do you think it is to educate and raise awareness of these kinds of places?

N/A	Not at All Important		Neither	Very Important	
0	1	2	3	4	5

By including this question type I have been able to collect a mixture of quantitative and qualitative data and to investigate how individuals respond to various heritage landscapes. Using descriptive statistical analysis, this method collated data to both describe and provide a summary of the characteristics of a sample population from each research location, including measures of central tendency and measures of variability (Rogerson, 2001; MacFarlane, 2014). Specifically, an average value of responses for each Likert statement was calculated to indicate the extent to which participants have agreed/disagreed with a statement. I was able to quantify the qualitative data into numerical form, input and glean the figures into computer software programmes (i.e., Microsoft Excel) for processing through GIS for data manipulation, visualisation, and representation.

The questionnaire was designed using a numerical and chronological structure whereby I was strategic in terms of which questions were asked next and what type of information and content I was asking for. This helped to help reassure participants that they were making progress with the completion of the survey (Parfitt, 2005; Remenyi, *et al.* 2011). Observed in Appendix B, the questionnaire was structured and divided into specific sections or categories. It started with a participant information sheet outlining key information about the project, such as the overall aim of the research, the purpose of the questionnaire, and how the participant is contributing to the work (Newcastle University, 2017). The questionnaire then began with a series of closed-ended questions, tick-box, and multiple-choice selections, for

participants to indicate the purpose of their visit, where they heard about the cultural, heritage sites, and how many times they may have visited beforehand. Additional closed-ended questions focused on collecting information about participant's attitudes and perceptions, and these were grouped so that the statements related to each of the sense of place components identified in Chapter 2.0⁴¹. Finally, I required personal details like gender, age, and address. Asking these last, the questionnaire finished with a variety of closed-ended questions designed to collect, sort, and classify more personal information about individuals into specific groups. The result was a fluid and easy to use questionnaire that held the attention of the participant, offering a degree of transparency to ensure clear consent by completion. I refrained from using jargon and other terms that participants may not have understood nor recognised, with clear syntax and sentence structure ensuring questions did not mislead the respondent (Parfitt, 2005).

On the other hand, questionnaires are susceptible to a series of challenges and limitations. Reliability and validity were two specific attributes that I felt a need to address in the design and conduct of my questionnaire. Specifically, I needed to replicate the method for further use, trust the collected information, and ensure that my method could provide a valid measure from participants whilst doing as intended (Parfitt, 2005). To minimise the implementation of either, the questionnaires were continually reviewed, drafted, and redrafted again as part of the piloting process outlined later⁴² (Remenyi, *et al.* 2011). There were also potential ethical issues to consider. As mentioned above, the questionnaire came with a participant information sheet to make sure the participants were fully aware of the research they were contributing to, how their details would be used, and be reassured that they would be kept anonymous (Remenyi, *et al.* 2011; Newcastle University, 2017). I wanted to make sure that the questionnaire was appealing to participants and maintained a degree of reassurance, by offering credible justifications for the research and implying a sense of trust. To do so, I many questions included a 'N/A (prefer not to say)' option as one of the tick-box responses, to make sure the questionnaire was user-friendly, approachable, and deterred putting participants off answering the questionnaire altogether (Veldwijk, *et al.* 2014). Although the surveys were continually redrafted and tested, there was still a chance that the participant did not understand, nor felt the need to provide a response. In this case, the not applicable option provided participants with the ability to opt-out from providing a response and to move onto the next if they wished. Alternatively, it had potential to persuade future answers if the

⁴¹ See Chapter 2.0, section 2.4.2 The Landscape Veil.

⁴² See section 3.5.2 Pilot Testing

questionnaire was supposedly not applicable to them personally (Hunt, *et al.* 2013; Veldwijk, *et al.* 2014). As a compromise, all participants were given the option that if they did not want to contribute to the investigation at any point, all details and data records were henceforth removed from the study.

During the first data collection phase in October 2016, I collected nine questionnaires from Esh Winning, eighteen from Stanhope and twenty-eight from Durham. In the second period of February 2017, I collected eleven from Esh Winning, nineteen from Stanhope and twenty-eight from Durham. In the third data collection phase for June 2017, I collected nine questionnaires from Esh Winning, twenty-six from Stanhope and thirty-three from Durham. In total, there were twenty-nine collected from Esh Winning, sixty-three from Stanhope and eighty-nine from Durham. On completion of each questionnaire, participants were invited to answer further questions as part of a semi-structured interview⁴³, to verify my records and divulge further description, reasoning, and justification if they felt comfortable to do so.

3.3.4 Semi-Structured Interviews

Questionnaires can be a very rigid source of information, whereby the data collection is predefined by the types of questions asked and determined by the types of data required. Interviews on the other hand, are much more flexible by nature and can adapt to both answers given, and the situations that the interviews are held in (Valentine, 2005). Being a face-to-face approach, they are a key method for establishing rapport with participants, to influence a more naturalistic conversation and allow participants to provide first-hand details, descriptions, and accounts of their own experiences (Shuy, 2003; Valentine, 2005; Irvine, *et al.* 2012). They allow researchers to create deeper, more detailed pictures regarding their research investigations, developing more meaningful analyses to facilitate stronger conclusions (Silverman, 1993, cited by Valentine, 2005). However, this does not suggest that interviews are a free flowing, unscripted data collection method. They too can include an agenda or itinerary of questions.

For this research investigation, semi-structured interviews were chosen as they allow for a level of responsiveness between the researcher and participant (Valentine, 2005). They used a series of questions relating to specific topics to provide direction, though the questions were open-ended for additional details (Punch, 2005; Bryman, 2016). For example, I could

⁴³ See section 3.3.4 Semi-Structured Interviews

introduce new questions to gather further context, alter the wording of the questions to ensure clarity and transparency, and vary the order in which the questions were asked (Bryman, 2016). I used the questionnaire as a tool for recruiting interview participants (Valentine, 2005). As there were no specific criteria regarding the sample and data population, I was able to gauge emotional and behavioural responses to assess whether respondents may be willing to answer additional questions. Doing so incorporated a level of flexibility that meant the closed-ended questions could be manipulated into a more open-ended formats (Polkinghorne 1983, cited by Elliot & Timulak, 2005). It was possible to ask why individuals may have revisited the location, what their previous experiences may have been at the site, and/or find out the reasons that persuaded them to visit for the first time. Consequently, an open-ended approach allowed individuals to respond to questions and feedback with their own answers, reasons, and justifications. Interview questions were not set too strictly within specific criteria and categories to keep that responsive quality, though maintained a certain degree of control and guidance.

Semi-structured interviews were also conducted with individuals that had not completed the questionnaire beforehand, again using the questionnaire as a guide to acquire relevant information for the research. I recorded responses and answers in context to the closed-ended questions used in the questionnaire, with the provision of additional reasoning and justification (Valentine, 2005; Bryman, 2016). It meant that the interview data was manageable during the collection and readily categorised for coding. As a result, it made the data collection quicker, and the resulting transcription and coding of the interviews more efficient (Bryman, 2016). It did, however, require taking note of additional considerations including logistics and management. I needed to be aware of whom I wished to interview, how many people I ideally wanted to speak to, when I was hoping to speak to these individuals, and for how long (Punch, 2005). Consequently, during the first data collection phase in October 2016, I collected five interviews from Esh Winning, twelve from Stanhope and nineteen from Durham. In the second period of February 2017, I collected six from Esh Winning, twelve from Stanhope and twenty-two interviews from Durham. During the third data collection phase for June 2017, I collected seven from Esh Winning, nineteen from Stanhope and twenty-five from Durham. In total, there were eighteen collected from Esh Winning, forty-three from Stanhope and sixty-six from Durham.

There was no focus to collect data regarding specific demographic groups, so any willing participant was able to contribute. I was not interested in collecting information primarily

from residents, visitors, students, females, males, or specific age groups as the research aim did not require it. The data collected could be aggregated into specific categories later. Regarding the population size, there was no set number or target suggested as part of the research design. Each site was of a different size and scale, thus difficult to try and collect the same number of responses for each location⁴⁴, though the sample sizes are discussed later in this chapter⁴⁵. The interviews lasted between five to fifteen minutes, depending on the responses given by participants and the level of detail and information they wished to share. It meant that there was enough time to obtain plenty of information from several individuals at each location yet complete the data collection. It required a balance to recognise which methods may require more time than others to complete, and how to prioritise these accordingly (Punch, 2005; Bryman, 2016). Additionally, by replicating the methodology three times over the course of a year, the questionnaire was also tested for replicability and validity, in that the data collection could be carried out on numerous occasions and the same data types and information measured and collected (Parfitt, 2005).

In summary, I have effectively developed this method and been able to manage the data collection process, planning and accommodating any necessary changes and adaptations to ensure data was of a consistent high quality, reliable and valid (Punch, 2005). For example, when the weather was particularly bad, I would alter my position to accommodate the participant. In Durham for example, there is a stone archway⁴⁶ next to one of the collection points⁴⁷ that I used to keep dry. Similarly, if any of the data collection points were inaccessible due to maintenance, organised events, or other unforeseen circumstances, I again adapted my position and altered the question perspective. Again, in Durham, there is a large, landscaped space⁴⁸ used for events that often hosts large tents/gazebos. This restricts the views of key landmarks and can influence people's perceptions of place. By accounting for these changes, I could make sure that the information gathered did reflect the opinions and perceptions of a person who would have stood at identified points, at each research location.

Furthermore, I did not use digital recording equipment, so all discussions were recorded immediately after the conversations had taken place. Each discussion was more informal by nature to promote a more naturalistic setting (Punch, 2005; Bryman, 2016). In doing so, I

⁴⁴ Discussed in section 3.4 Research Sites

⁴⁵ See section 3.5.3 'Sampling'.

⁴⁶ Features are explained in more detail in section 3.4.3.

⁴⁷ Data collection points are explained further in section 3.5.

⁴⁸ Features are explained in more detail in section 3.4.3.

found participants more responsive and it gave individuals time to think about their answers, either those originating from the questionnaire or generated entirely in response to the semi-structured interview. Though interviews are often video/tape recorded by the researcher, I felt it to be unfeasible to do so and would have required informed consent and arrangements for necessary equipment. Instead, I was reliant on my notetakings of each conversation, writing information and detail by reflection for digitising and transcription later. I did however keep an ear out for evidence of themes that coincided with the Likert Scales, such as attachment to place, social relations, adaptability of use, landscape appreciation, and landscape satisfaction (see Appendix B). It meant that whilst I was not able to record entire conversation, I was able to note key pieces of evidence that linked to specific themes and concepts and be aware of what the participant was saying and how they said it (Bryman, 2016). Additionally, I was conscious of the emotional and bodily reactions/responses to each unique conversation and situation, to make sure I did not put my participants under any pressure or stress.

3.3.5 Secondary Data and GIS

In this research investigation, secondary data was required to supplement and support the research investigation (Kitchin & Tate, 2000). Obtained and produced by somebody else for other purposes and motives, this included the collation of; pamphlets, leaflets, and information from websites for use in the background research of the research sites; and census, satellite, and geographical information like boundary data to support the creation of cartographic representations. The investigation specifically used information obtained from government agencies and other approved sources, these being the UK Data Service (2018a) for aggregated census data, Edina Digimap (2018) which collected Ordnance Survey data to use in GIS, and the World Imagery function in ArcGIS that provided both satellite and aerial imagery for use as base maps (ArcGIS, 2018). Initially, GIS was used for its technological and computational abilities, to store, analyse and process data (Chrisman, 2003; Longley, *et al.* 2005). Secondary datasets like the census and boundary data provided the quantitative context to associate qualitative data from the interviews and participant observations, using shapefiles and corresponding attribute tables to tabulate data to a specific point and geographically referenced file. This associated the second purpose of GIS as a series of processes and practices, in the subsequent generation and presentation of new geographical knowledges.

Specifically, I needed to research and source secondary information so that I could conceptualise understandings and acquire information that was not readily available in

accessible form (Kitchin & Tate, 2000). I used secondary data to supplement my work and add further depth and context for the interpretation of primary data sets. Methodologically, data from the UK Data Service (2018b) via the CASWEB portal and Edina Digimap (2018) can be replicated across several studies and projects as the data providers aim to share information to all whom have a need. Its availability as a data source is a key tool for projects like this one, because the ability to collect the information first-hand is both expensive and almost impossible as it requires access to government satellites, specific permissions, and so on. As part of a mixed-methods approach, both the qualitative and quantitative, primary, and secondary data sets were assembled and used together as a methodological tact, combining all the relevant data types effectively as part of an integrative approach (Kitchin & Tate, 2000; Gregory, *et al.* 2009; Elwood & Cope, 2009).

GIS was used as part of a qualitative GIS approach, to process and analyse not only quantitative data sets, but also the qualitative (see Elwood and Cope, 2009; Aitken & Kwan, 2010). Being a flexible practice, it has the potential to fuel research and contribute to geographic enquiry, by integrating various sources of knowledge from a variety of research methods (Elwood & Cope, 2009). It was this integration that facilitated the visualisation of patterns across both time and space, observed later in the thesis (Elwood & Cope, 2009; Aitken & Kwan, 2010). For example, whilst quantitative methods tend to focus more on the measuring of the phenomenon and are recorded through numerical values, qualitative methods aim to collect and record information for further explanation, to query the deeper meanings and description about various social and geographical events (Dwyer & Limb, 2001; Aitken & Kwan, 2010). GIS provided the technological advancements to create representations capable of exploring qualitative datasets, whereby I considered it part of a 'bricolage' to discover more by linking the qualitative detail with spatial data (Aitken & Kwan, 2010:290). On the other hand, knowledges that are created and presented in this manner are still limited and remain a partial representation. Whilst the methods to collate such information are replicable within other research methodologies, the data is still only representative of a very small snapshot of time (Elwood & Cope, 2009). This information cannot answer all lines of enquiry and subsequent questions, but the datasets can contribute towards building bigger, better pictures about phenomena; pooling knowledge from within research disciplines, to formulate more collective, more in-depth discussions and results.

There are a variety of possibilities for incorporating qualitative detail through GIS (Jung, 2009), whereby I used some of these ideas and motives to facilitate and create my own.

Photos can be georeferenced to specific points on an ordnance map, linking the photograph to the physical, spatial content it represents (i.e., a Durham Cathedral). These points provide a means for linking information to identified places, to consider initial methods of spatial analysis. I used a similar approach with my interview coding noting the landmarks and monuments mentioned by participants in their discussions⁴⁹. These points were used to organise the spatial knowledge within the qualitative datasets, for processing and presenting in some form of cartographic representation. A specific example that I did research for this investigation was Cooper & Gregory (2011), whose work uses historical, secondary data sources through a 'Literary GIS' to create cartographic representations based on personal accounts and narratives. By transcribing two diary accounts and noting place names, opinions and emotive language, this data was categorised into specific themes/concepts and plotted in accordance with the identified location. This consequently produced visual representations of the grouped emotions and feelings experienced around each pinpointed location (Cooper & Gregory, 2011) and provided the motivation for this research to do so in a similar way.

There are still issues regarding the characteristics of data files being lost in these collective and manipulative processes. Noted previously⁵⁰, data categorisation can remove the context that both describes the data and the reasons to which the record was noted, under the assumption that all records noted within a category are for the same reason, rather than dependant on the person who provided the information (Schuurman, 2009). This, however, is an issue that is not easily resolved. Instead, I have tried to use the wealth of primary data and detail to support the relationships, patterns and connections appearing from within the datasets, to continuously justify what these visualisations may mean regarding people and place. Additionally, this also relates to data aggregation. By collating results under more generic themes or wider spatial scales, details, anomalies, and potential outliers can become masked and hidden by the generalisation of the findings (Knigge & Cope, 2009; Jung, 2009). Greater spatial scale can restrict the visibility of patterns between themes and categories of data however, this study required more microscale observations, pinpointing specific locations around each cultural heritage site to link the qualitative data to identified spatial references. Doing so enabled the relationships between people and place to be visualised not by city or region, but by specific geographical reference to observe the potential landscape factors that may have contributed to those findings.

⁴⁹ Discussed further in section 3.6.3 Coding

⁵⁰ See Schuurman (2009) regarding the loss of data characteristics in section 2.2.2 Qualitative GIS

By integrating various methods and data types, I have further evidence to support the use of mixed-methods and GIS, strengthening the explanatory power of analysis by enabling more meaningful interpretations of data (Pavlovskaya, 2002; Jung, 2009). My motive was to create an alternative approach for exploring qualitative detail and observe the geographical trends and patterns within collated datasets. Here, the research conceptualises that GIS can be used as a representational, analytical tool, by using qualitative data to add further depth and context to spatial data and associating the relevant meaning and description. Specifically, qualitative GIS can combine both secondary quantitative datasets and primary qualitative accounts, to conduct more detailed, more in-depth analyses and observations of research (Jung, 2009; Elwood & Cope, 2009; Aitken & Kwan, 2010). It encompasses the four areas of commonality of grounded visualisation, to collate and integrate ethnographic information with spatial data and present the emerging stories for analysis (Knigge & Cope, 2006; Yau, 2011).

3.4 Research Sites

The following three research sites are places located in the North East region of England, set within County Durham. Using Figure 8A below, Esh Winning is located to the north of Bishop Auckland in the centre of the map, with Stanhope located 18-20km to the west, and Durham City 8km to the east. The following subsections provide a brief overview of the areas and identify key features and attractions that make each location unique, before providing a justification of their suitability to the research investigation.

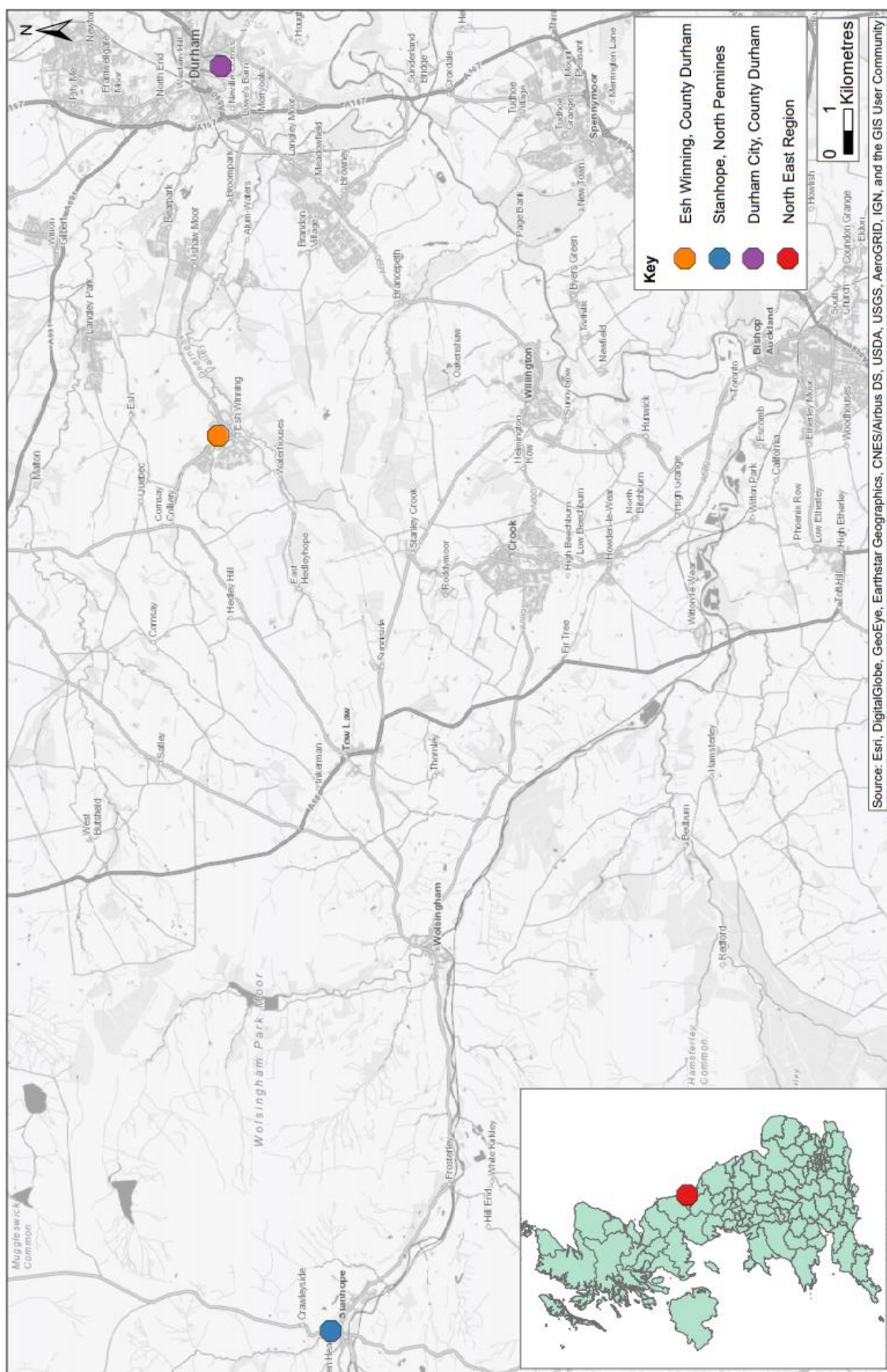


Figure 8A: Research Locations, County Durham

3.4.1 Esh Winning, County Durham

Esh Winning is a former colliery village located to the west of Durham City (Ordnance Survey, 2018a). Its most prominent feature is the Deerness Valley Path, which runs from Crook to Broompark along an eight and half mile trail (This is Durham, 2018a). Originally named ‘The Deerness Valley Railway’, this line used to carry coal from Crook to Brancepeth, passing through Stanley Crook, Waterhouses, Esh Winning and Ushaw Moor (This is Durham, 2018a). It carried passengers between 1878 and 1951 before the line was entirely shut to freight in 1964, and today no evidence of a terminus exists at Esh Winning (Lambeth & Catford, 2017). Observing Figure 8B below, the path itself follows the River Deerness along the Deerness Valley and is accessible in the present day for walkers, cyclists, horse-riders, and wheelchair users in most areas.



Figure 8B: Esh Winning, County Durham

3.4.2 Stanhope, Weardale

Stanhope is a small market town also located to the west of Durham City, situated in the Weardale (Ordnance Survey, 2018b). Set within the North Pennines, the area is a designated Area of Outstanding Natural Beauty (AONB) due to the surrounding natural landscape and features of woodland and rivers, its mining and industrial heritage, and abundance of flora and fauna (North Pennines, 2017). It is also a UNESCO Global Geopark, which further implements the area's globally recognised heritage (North Pennines, 2017). A brief history of Stanhope includes acknowledging the origins of Anglo-Saxon meaning 'stony side valley', as the town is situated alongside the River Wear (Stanhope Parish Council, 2016). It was originally a farming community until the industrialisation of lead extraction and the building of the railway influenced its expansion in the sixteenth century (Stanhope Parish Council, 2016). Today, there is little evidence of this history aside from some remaining features in the surrounding landscape and the architecture of the houses. Stanhope is instead more well-known for its agriculture and landscape aesthetics. Stanhope is also home to Stanhope Station, being the terminus for the Weardale Railway which ran from Bishop Auckland to Wearhead transporting material and passengers from the mines to various iron and cement works (Weardale Railway, 2017a). The station has since been refurbished and restored by the Weardale Railway Society, the Wear Valley Council, and the Wear Valley District Council, who bought the station and building in 1992 (Weardale Railway, 2017b). Upon its reopening in 2004, the station now runs a passenger service between Stanhope and Witton-le-Wear between the months of March and October, hosting a series of seasonal, family-friendly events. Observe Figure 1C:

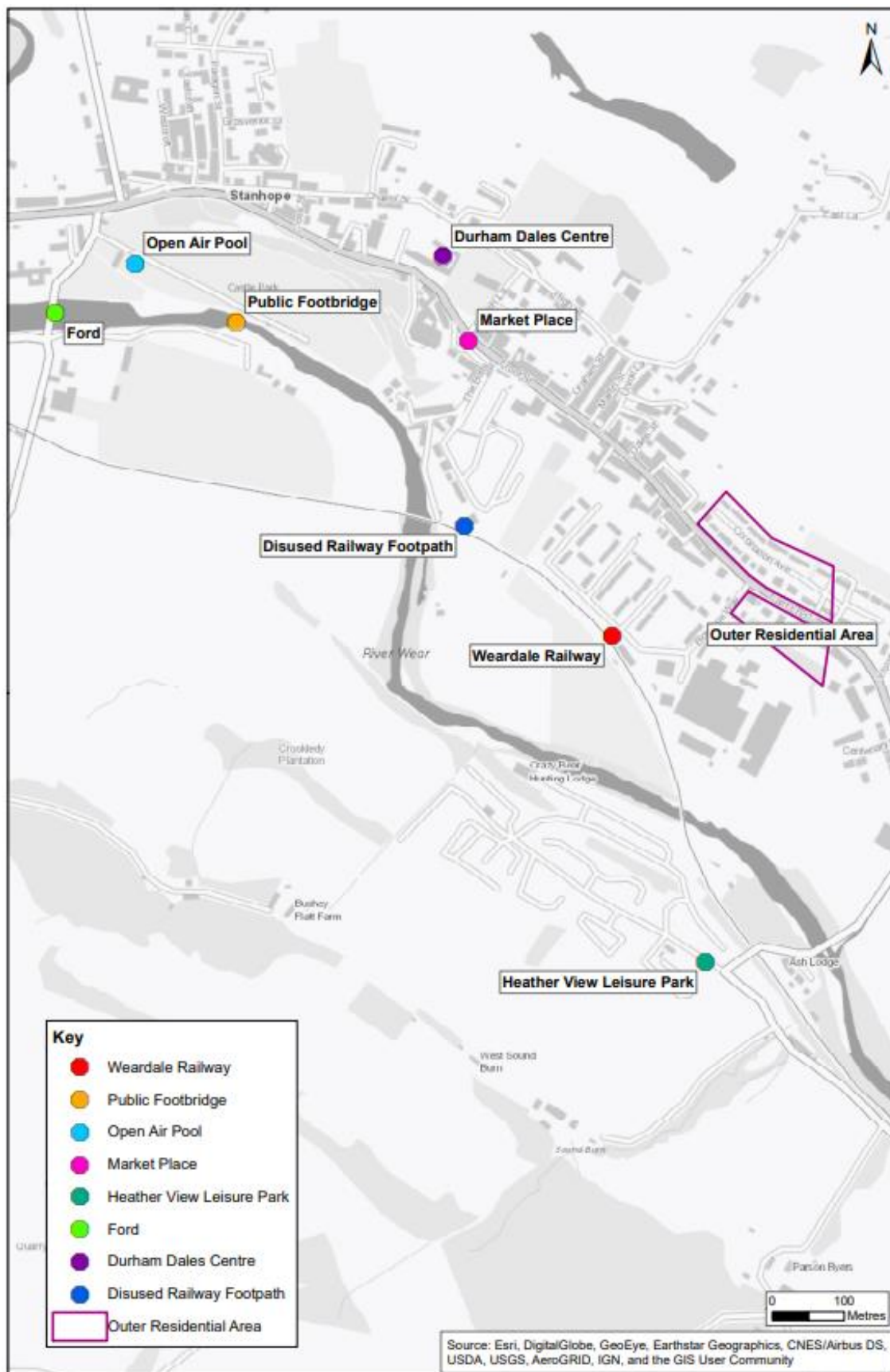


Figure 8C: Stanhope, North Pennines

There are several other points of interest in and around the town of Stanhope, pinpointed in the above Figure 8C. Each provided unique vantage points to consider where best to conduct the research and take advantage of participant availability. Each point of interest is unique and encompasses a degree of historical and cultural context, contributing further to the perceived identity of Stanhope. These included:

- Durham Dales Centre:

The visitors centre named the ‘Durham Dales Centre’, which has tearooms, tourist information service, and an array of boutique and craft shops (Durham Dales Centre, 2018).

- The Fossilised Tree:

A ‘petrified’ tree stump located in the churchyard of Saint Thomas Church, originally found at the local Edmund Byers Cross Quarry, and estimated to be c.560million years old (This is Durham, 2018b; Stanhope Parish Council, 2016)

- Stanhope Castle:

The local landmark ‘Stanhope Castle’ and estate were originally hunting grounds for the Durham Bishopric, eventually acquired and rebuilt in the 1700’s after it fell into disrepair (Stanhope Castle, 2017). It became a School for Boys in 1941, before being turned into private apartments in 1980.

- Front Street:

Running through the centre of Stanhope, Front Street is a long line of terraced shops with buildings dated from the seventeenth, eighteenth, and nineteenth century (Stanhope Parish Council, 2016). At the east end, there are a series of houses built purposely for the quarry workers in the area, the historical connotations evident in the building’s architecture.

- The Ford and Steppingstones:

A steppingstone crossing can be found across the River Wear, located down by the ford. This area links the riverside walks which lead back towards the town centre (Stanhope Parish Council, 2016).

- Open-Air Swimming Pool:

One of only two Open Air Swimming Pools found in the North-East, the pool is often used in the summer by both locals and visitors to the area (This is Durham, 2018b).

3.4.3 Durham Peninsula (Castle and Cathedral), Durham City

The third research location is Durham City, set approximately thirty kilometres south of Newcastle upon Tyne (Ordnance Survey, 2018c). Founded in 995AD, the city sits on the banks of the River Wear with its most prominent and historical landmarks towering above on what is known as Durham Peninsula (Simpson, 2017). Specifically, this area is key to the research investigation because it is home to one of the city's most iconic buildings, Durham Cathedral (This is Durham, 2018c). Together with Durham Castle, the peninsula area was inscribed on the UNESCO World Heritage Site List in 1986, in response to the area's 'Outstanding Universal Value' (UNESCO, 2018). Observe Figure 8D:

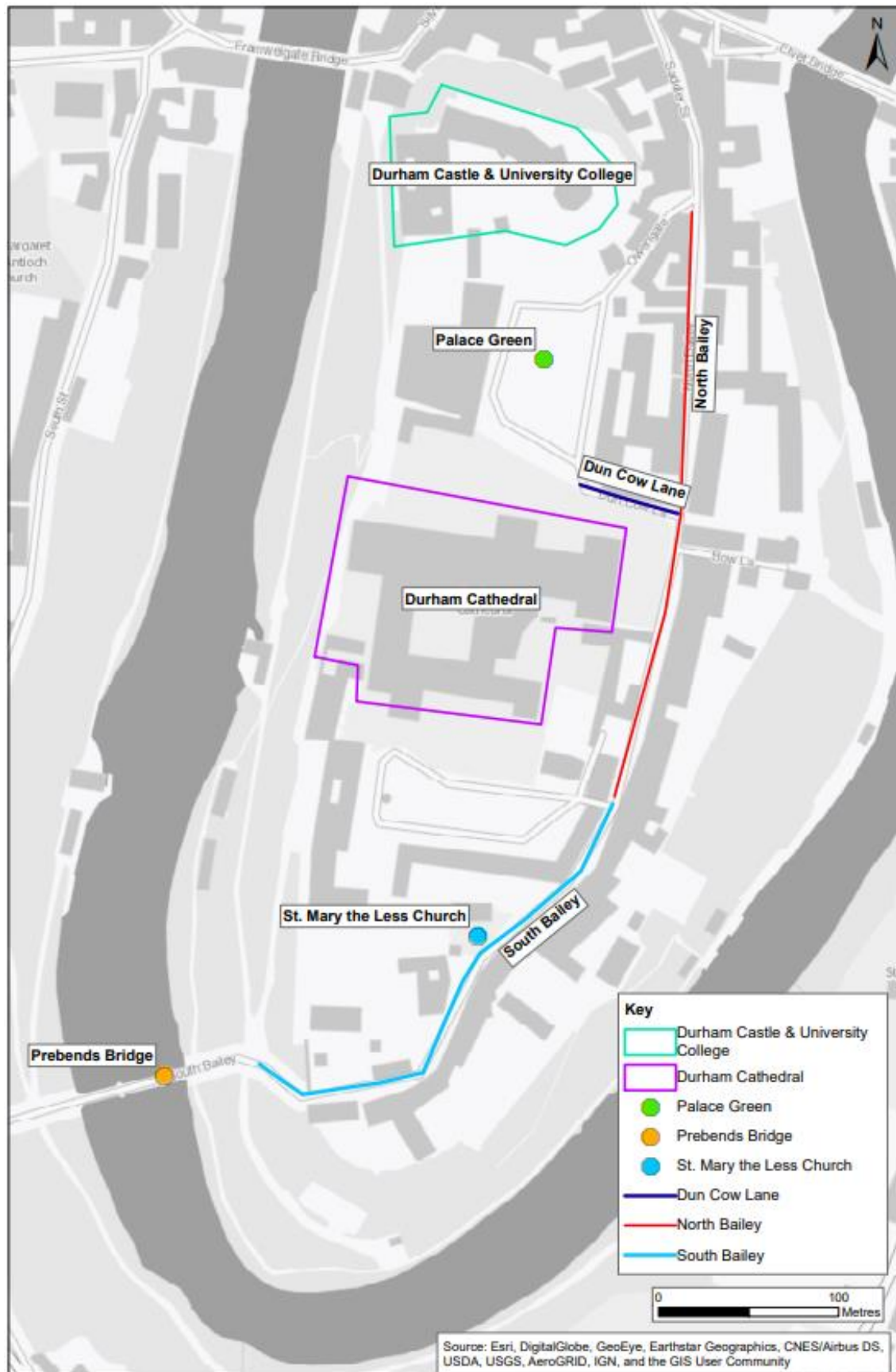


Figure 8D: Durham Peninsula, Durham City, County Durham

There are many points of interest in and around the main centre of Durham, however, the main research area was that of the peninsula. Thus, the following sites have been detailed because of their relevance to the investigation and data collection. In Figure 8D I have pinpointed:

- Durham Cathedral:

The cathedral's history is associated to the founding of Durham City itself and a monk named St. Cuthbert; a bishop whom after his death and burial on Lindisfarne, was later proclaimed a saint (Simpson, 2017). Pilgrims came from all over to visit the coffin of St. Cuthbert bringing riches and wealth to Lindisfarne, which in turn attracted the Vikings and brought raids and plundering to the island. As a result, the monks fled the island with St. Cuthbert's coffin, travelling around the north for an adequate resting place and settling on 'Dun Holm'; an ideally defended site on high ground, with steep sided banks and the gorge of the River Wear (Simpson, 2017). Here, a temporary structure was built to house the coffin and over the centuries was replaced by more permanent stone structures. The cathedral today was built in 1093 and is famous for its Romanesque architecture, though it is also known for the key political and military role it had in reinforcing the authority of the Prince Bishops, power that was granted by the English King to the Bishop to control the land in the border region (Durham Cathedral, 2018).

- Durham Castle:

Located at the northern end of the peninsula, Durham Castle was commissioned for building in 1072 by William the Conqueror. It soon passed hands to the Bishop of Durham, who bought it and became the very first Prince-Bishop of Durham (Durham Castle Museum, 2018a). The Castle is notably famous for its Norman history, becoming a fortress to protect the Prince-Bishops and their community; with stone walls that would have ran around the outskirts of the peninsula, and several gated entrances/exits to control access to the main site (Durham Castle Museum, 2018a). Today, the Castle is home to University College, founded in 1837, after the University of Durham was established in 1832 (Durham Castle Museum, 2018b). The Castle itself claims to have the 'largest and most perfect monument of "Norman" style architecture in England' and is still used today as a place of worship, education, and residence for students, contributing to the authenticity of the site (UNESCO. 2018).

- Palace Green:

Located in front of the cathedral and castle, this was once the original city marketplace (Durham World Heritage Site, 2018a). Today, it is a much quieter place where; visitors can relax and visit the surrounding buildings; students are often seen reading and socialising, and individuals can meet up with family and friends. It is often used by the Castle College and

Cathedral for various events throughout the year, such as hosting graduation ceremonies or re-enactments of the historical markets. The square is framed by a variety of buildings, including the Palace Green Library, Almshouses and Grammar School, Exchequer Building (which housed the Bishop's court) and Cosin's Hall (once student halls, now university buildings); each bringing different examples of historic architectural styles and structures (Durham World Heritage Site, 2018a; UNESCO, 2018).

- The Baileys:

The Baileys is an area of the peninsula that runs along what used to be the eastern Castle walls. Now split into two sections, the North Bailey has many buildings along its route that date back to the seventeenth century, several of which are now used to house Durham University students, key institutions like Hatfield and St. Chad's College, and Durham Museum. The South Bailey, on the other hand, is home to St. John's College; an independent place of study originally for those who wished to become ordinands for the Church of England (Durham World Heritage Site, 2018b). South Bailey is also home to several student accommodation blocks for Durham University, and can be used to access Prebends Bridge at the most southern point of the peninsula.

- Prebends Bridge:

Of all the bridges that span across the River Wear linking Durham City to the surrounding areas, Prebends Bridge is arguably one of the most visited due to the views that the site offers (Durham World Heritage Sites, 2018c), being the steep-sided, wooded riverbanks, the cathedral, and down river towards the outskirts of the city. Historically, bridges represented wealth and riches in an area, especially to the landowners, the patrons and in this case the Bishop, who commissioned their build (Mortimer, 2009). Located at the south-west end of the peninsula further along from South Bailey, the bridge is used mostly by foot passengers going to and from the city itself and is a Grade I listed building/structure (Durham World Heritage Sites, 2018c; Historic England, 2018).

3.4.4 A Justification

The reason for choosing Esh Winning, Stanhope, and Durham peninsula as my three research locations stemmed from wanting to incorporate sites that provided a range of qualities, characteristics, and attributes. These locations ensured my methods were capable for use regarding diverse data representation, with each location characterised by a range of cultural, historical and heritage contexts. Specifically, Esh Winning is a former colliery village set in amongst surrounding countryside of moorland and coniferous woodland, with an underlying history associated to the railway. There were no specific attractions or commemorations to the

railway in the areas that I conducted my research methods in, so its heritage was less upfront than the other locations. Stanhope is a small market town and even more so acquainted with the surrounding landscape and countryside, as the area is a designated AONB and UNESCO Global Geopark (This is Durham, 2018a). The town is much larger than Esh Winning and has more noticeable ties to its local heritage, including historical connotations from the Weardale Railway attraction and Stanhope Castle. Durham peninsula is an area within Durham City. It is a well-known location due to the history and heritage evident in the cities make-up, from the architecture and cobbled streets, to the surrounding landscape and World Heritage recognised landmarks and monuments. Being the most urban settlement, my choices for the three sites are reflected in the scale of rural to urban, each one providing unique settings to test and investigate people's interpretations of landscape.

Additionally, the varying levels of history and heritage are represented through physical features and markers found upon the landscape, at each location. Esh Winning, as I have already noted, appeared to have a more hidden association to its history and heritage, with little visual indication of the areas past. Stanhope and Durham each have tourist attractions relating to key landmarks and monuments that almost signpost their heritage, whilst Esh Winning does not. Stanhope and Durham are more alike in terms of a heritage assessment, as each has; designated protected sites that encompass a degree of importance and significance; key features that contribute to the location's identity, whether natural or man-made; and historical architecture that suggests the age and importance of each location. However, Stanhope is not a UNESCO World Heritage Site though it is an AONB and UNESCO Global Geopark, deemed to have a globally significant Earth heritage (North Pennines, 2017). Stanhope has a geological and environmental importance stemming from its surrounding landscape and variety of natural features, flora, and fauna, hence its designation as an AONB. In comparison Durham's peninsula area is a designated World Heritage Site due to the 'crystallize[d]' memory of Northumbria and the Benedictine life within the fabric of the buildings and community (UNESCO, 2018). It holds sustained and invaluable evidence reflecting the wealth, importance, and significance that the area once held and continues to do so.

Regarding the research aim, these locations provided a range of qualities and attributes that contributed towards each unique cultural heritage landscape. With my focus on landscape perception and the bonds between people and place, I used these locations to compare my findings and consider the engagement between people and landscapes. With the identified

points of interest for each site, seen in figures 8B-8D, I was able to query how responses may differ both within and between locations, and be influenced by surrounding physical, environmental, and spatial factors. Furthermore, conducting research over several time periods presented an additional temporal quality to see how perceptions may vary at different times of the year. Consequently, my choices have enabled me to examine methods, tools, and techniques for quantifying qualitative data, assess a variety of data visualisation methods, and explore how people formulate relationships with place.

3.5 A Collection Strategy

To create effective cartographic representations, I created a data collection strategy that would enable me to implement the necessary spatial attribute throughout the entire research process. It required strategic, systematic, and selective planning of where to conduct and replicate each of the data collection methods, so that it was possible to associate a specific spatial reference to the datasets for plotting through GIS. This not only facilitated the familiarisation of the research sites, but it also allowed me to plan my data collection methods more thoroughly, acknowledging the unique environment and setting of the research site(s), the land use and visual aesthetic, and varying levels of participant availability. It ensured that I could gather detailed information about my research sites, prior to going out into the field (Axinn & Pearce, 2006). Whilst it is highly recommendable that researchers gain some knowledge of their research environments, Elliot & Timulak (2005) argue that this can have a negative effect on the data collection, interpretation of results and analysis. It is believed that prior assumptions and acquiring of secondary knowledge could ‘taint’ my perceptions, limit my ability to remain objective and enable the data to describe occurring phenomena (Elliot & Timulak, 2005:148). Bias, however, is unavoidable. To reduce the effects of such, I took note of any prior understandings and ideas I had begun to formulate. I did not dismiss them but used them to reflect and situate my personal expectations as part of my work (Elliot & Timulak, 2005).

3.5.1 Data Collection Points

The collection strategy began by allocating data collection points (DCPs), at each of the research locations. I made preliminary site visits to each of the three sites to identify areas that would be suitable for the data collection, and to pinpoint key areas of interest for gathering relevant detail, description, and information (Schlossberg, *et al.* 2007). As a systematic and strategic approach, the DCPs were used as focal points for conducting and replicating the data collection methods across the three sites. However, similarly noted in the audit survey

discussion, each of the three research locations differed in size meaning each site has a different number of DCPs. Specifically, the bigger the size and scale of the site, the more DCPs were required. In response to the familiarisation visits, to try and allocate the same number of DCPs at each site would have increased the risk of observations and records overlapping and information being duplicated in the collection process, thus misinterpreted later as unique pieces of data.

The DCPs have each been given specific labels corresponding to the host site, capitalised initials correspond to placename and a number associates a specific point. These are in numerical order, with the research methods being completed in accordance with the sequence.

- Esh Winning (EW)

Figure 9A below presents the five allocated DCPs at Esh Winning, plotted along the Deerness Valley Railway Path. EW1 is in the centre of the village by the main road, EW2 is located the farthest south-west towards Waterhouses, and EW3 is the most centralised point, by the bridge to Ragpath Wood. EW4 is located on the footpath, by the Northumbrian Water Authority Sewage Treatment Works, and EW5 is the farthest north-east on the path opposite Flass Hall, which is a privately-owned place of residence, surrounded by farmland.

- Stanhope (ST)

Figure 9B shows the nine allocated DCPs mapped across Stanhope. ST1 is located to the farthest north, by the Durham Dales Centre, ST2 is in the town centre by the marketplace, and ST3 is located to the east towards the residential areas of Stanhope. ST4 is located outside Stanhope Station on the Weardale Railway, amongst residential and industrial land uses, whilst ST5 is to the farthest south-east outside a holiday park called Heather View Leisure Park. ST6 is located to the farthest west, on the southern bank of the river by the ford, ST7 is outside the Weardale Open Air Pool, on the northern side of the river, ST8 is a short walk along the river, by the public footbridge, and ST9 is the final DCP, located by the public footpath on the disused Weardale Railway Line.

- Durham (DC)

Figure 9C is the third representation identifying eight DCPs allocated around the peninsula area. DC1 is located on Prebends Bridge to the south-west, DC2 is on South Bailey in view of St. Mary the Less Church, and DC3 is located at the start of North Bailey opposite the stone archway that leads to privatised land at the back of Durham Cathedral. DC4 is a short walk towards Dun Cow Lane, in view of the stained-glass windows on the eastern side of the Cathedral, DC5 is by the traffic lights on the corner of the cobbled street that leads up to the Palace Green, and DC6 is in the north-west corner of the Palace Green, outside of Durham

Castle and University College. DC7 is outside the cathedral, on the south-west corner of Palace Green, and DC8 is behind the cathedral at the top of the privatised land, which can be accessed via the stone archway from DC3.

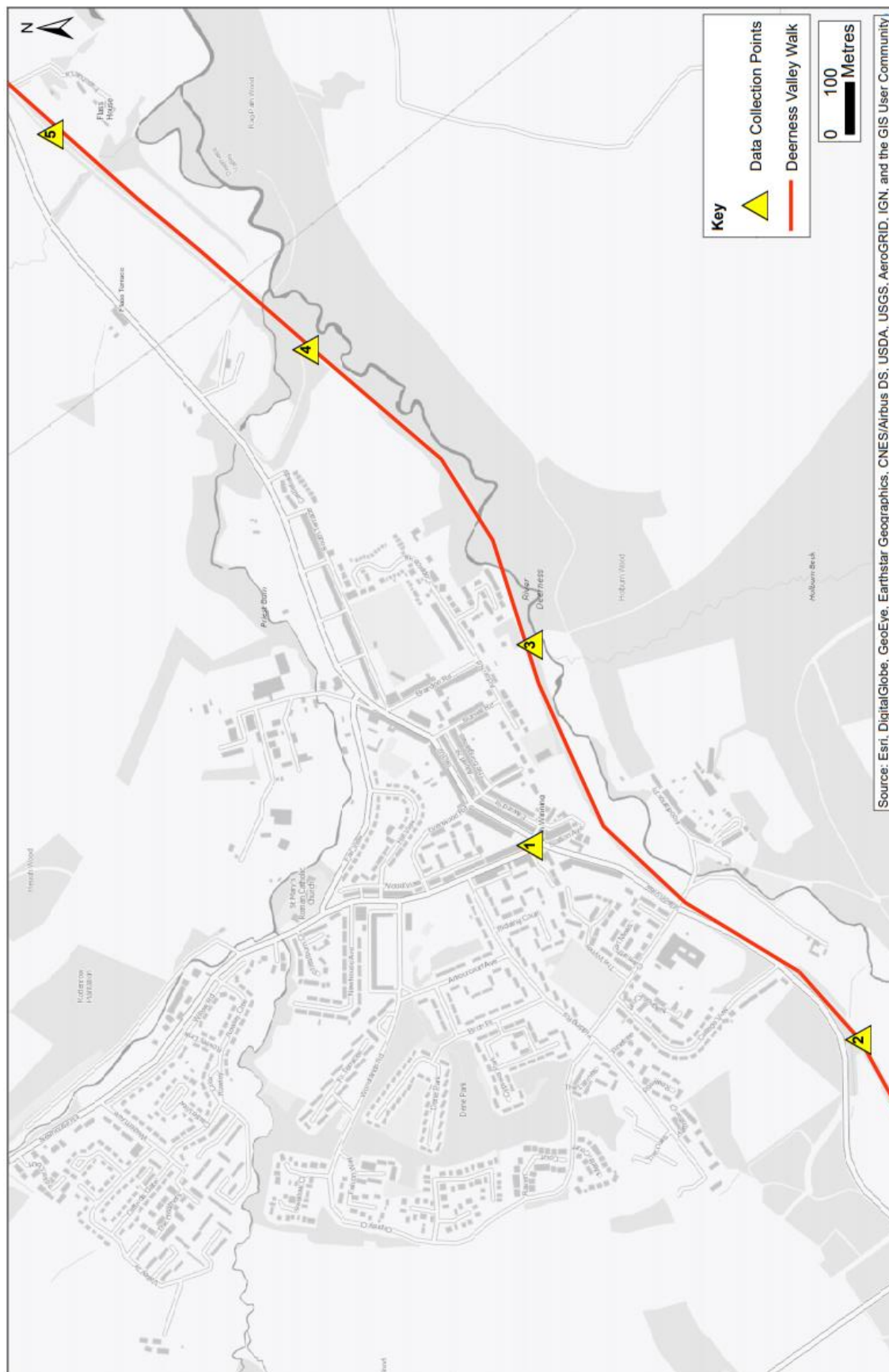


Figure 9A: Data Collection Points: Esh Winning, County Durham

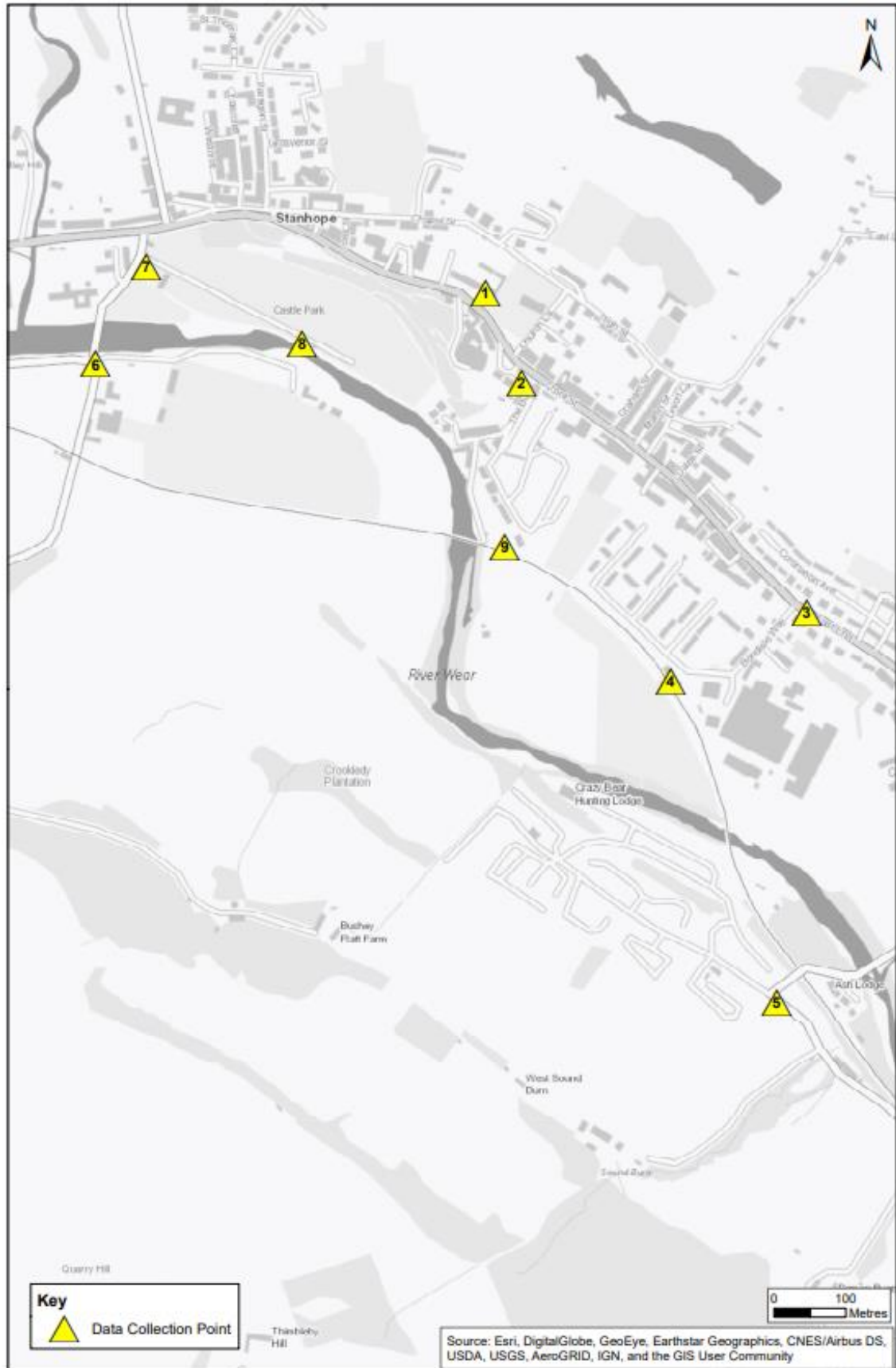


Figure 9B: Data Collection Points: Stanhope, North Pennines

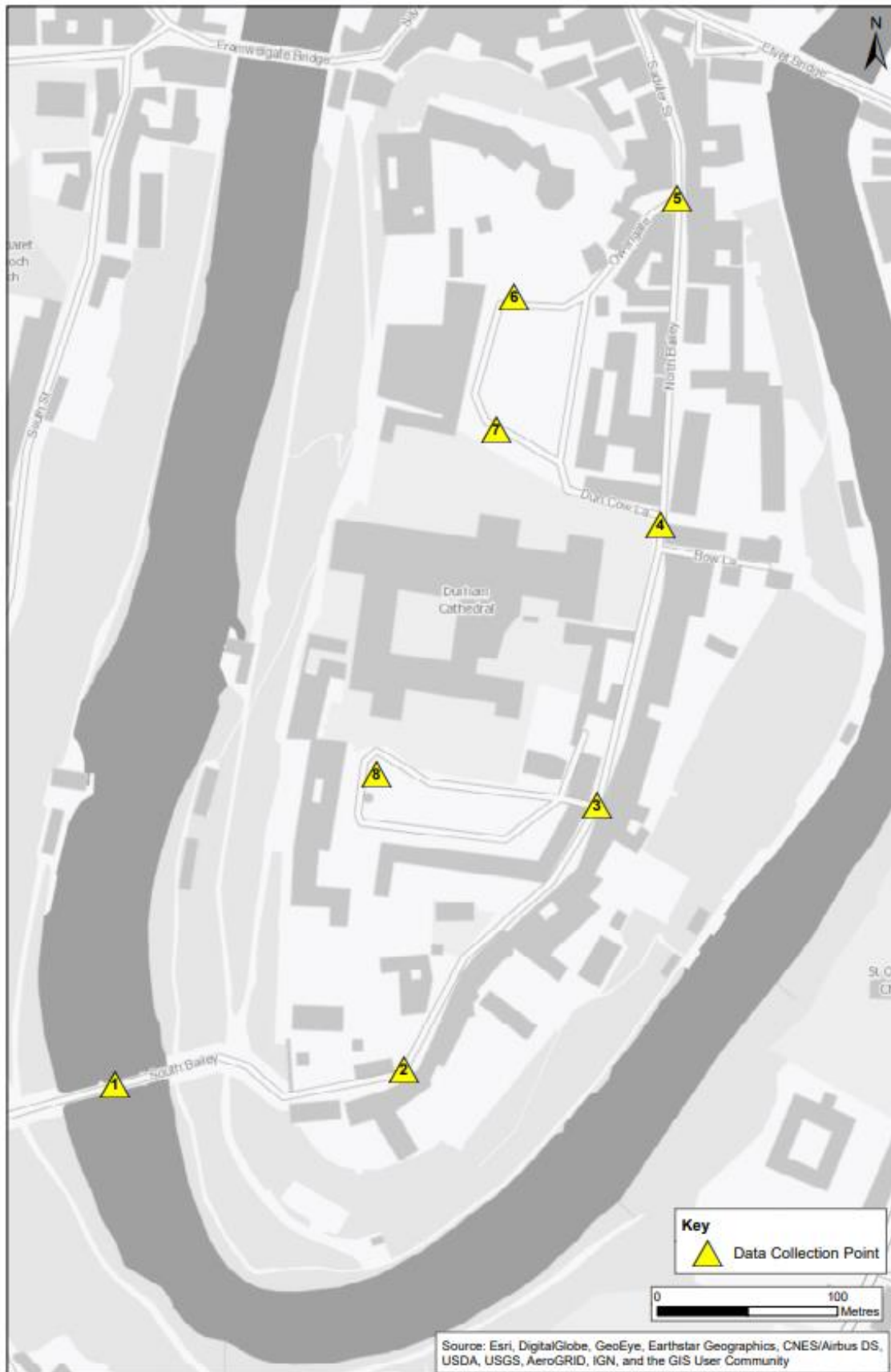


Figure 9C: Data Collection Points: Durham Peninsula, County Durham

3.5.2 Pilot Testing

Pilot studies were carried out at each location to test the initial parameters of the study and data collection methods. It was a useful process for making sure that DCPs were neither too close nor too far away from one another, that they did not overlap and run the risk of collecting duplicate datasets, i.e., where the same information, such as land use or street characteristics, could be recorded at more than one DCP. The pilot studies enabled additional checks regarding each of the methods, including suitability, validity, associating the relevant protocols, to ensure that the tools designed for the study were replicable and would facilitate the research needs (Parfitt, 2005; Axinn & Pearce, 2006). I was able to make sure that they would collect information effectively and efficiently from within a variety of environments and settings, across three differently sized, differently scaled research locations.

Considering this research methodology, I want to provide more specific examples and explanations relating to the primary data collection, noting the methods that required further drafting, editing, and piloting.

- Participant Observations

Participant observations incorporate a risk of the ‘subjective to objective’ argument (Schlossberg, *et al.* 2007:9), where the assumptions and recordings taken during the data collection may not be entirely accurate. In this investigation, focusing on the participants themselves could exemplify the subjective aspect of the study, whilst focusing on specific landscape features and physical features could exemplify the objective. However, I was mindful that all records were based upon my own interpretations of the environment, of either the social interactions or of material and physical attributes. Keeping my observations more covert, I purposely did not use clipboards. I found that I could blend in with my surroundings and reduce the risk of individuals formulating assumptions and stereotypical outlooks about me. Instead, I used a notebook for the piloting of the method to test my observation agenda and considerations, and in the resulting data collection.

Regarding the observation agenda and considerations, by using criteria or guidelines my observations were better framed and reduced the risk of recording potentially irrelevant detail. For example, the first category of observations I observed regarded the location itself, specifically, the time, date and which DCP I was recording at. I then looked at more descriptive factors regarding the environment and features, including landmarks, monuments, functions and other material aspects present, and the demographics, such as age and gender, the types of people in the area (i.e., groups, families, couples, and so on), and any distinctive

characteristics about them (i.e., shopping bags, prams, and dogs). I had an additional three categories of observations to record details about, though these were more interpretative and based on personal understandings and assumptions. These included determining the purpose of people's presence by interpreting behaviours and highlighting evidence to support those judgements, atmosphere regarding feelings and emotions seemingly constructed around each DCP with corresponding physical evidence that supported my observations (i.e., grey clouds creating an ominous atmosphere, versus bright sunshine and positivity), and the interactions and behaviours between individuals and the space, with other members of the public. It also included the kinds of conversations could I overhear that contributed to my understandings (i.e., friendly conversation, meeting and greeting, and so on).

However, there are always limitations and restrictions that can impede the effectiveness of participant observations, such as misinterpretation of information, missing out details, or simply being incapable of observing and recording everything at once (Kawulich, 2005). Instead, photographs supplement my records as further evidence of various observations relating to my research agenda. Consequently, it was a fine balancing act to take note of observed behaviours within specific locations, considering specific variables and themes (i.e., aesthetic appreciation), whilst pinpointing the physical attributes that may influence/contribute to the observed phenomena. The piloting was therefore a good opportunity to practise and fine tune my technique for the official data collection process. Though I did not need to change my approach to recording information, I was able to better my skillset and ensure that the method was applicable to the identified research sites and subsequent DCPs.

- Audit Surveys

Day, *et al.* (2006) stress the need to pilot test audit surveys to ensure applicability, feasibility, and the collection of necessary information and data required for analysis and eventually visualisation. The audit surveys had to be suitable and replicable across each location and accommodate both predominantly urban and rural landscapes (Yousefian, *et al.* 2010). Piloting was essential whereby my research sites ranged from more typical rural settings to those better acquainted with urban, built up areas, with landscapes that ranged from natural features of rolling hills, fields, and farmland, to those of cityscapes with road networks, commercial services, and various man-made features, landmarks, and monuments. Thus, it was necessary to change and adapt the various audit survey examples to accommodate my needs and the research specification. My focus became to create a rubric that included more

rural contexts of the physical environment, offering an example that other researchers could develop for independent use.

I conducted the pilot and data collection process hence no further training or expenses were required. I used the collection strategy to pilot the method, making sure each DCP was able to provide some form of relevant response, and that the DCPs did not overlap to produce duplicate records. As Guo & Loo, (2013:127) discusses, there is no singular method or ‘assessment [that] can satisfy all needs.’ By devising my own rubric as part of a mixed-methods approach, I found I could record observations of a more rural context and use this information alongside other collated details. The categorisation of information enabled clear management of the content, so that I could compare different data types against one another, gaining a better insight and a more balanced and inclusive understanding of social, geographical phenomenon. By doing so, I have contributed to a larger body of work. By developing a more rural-based audit, this can be used in future for mapping the physical environment and investigate social relationships within other types of setting and landscape (Elliot & Timulak, 2005).

- Questionnaires and Semi-Structured Interviews

Again, the questionnaires had to be replicable at each location whereby initial testing found that the Likert Scales were limited, as not all genres of statement were transferable across each location. I had to incorporate both urban and rural contexts and settings. For example, the statements became more generic, rather than refer to specific features and landmarks. However, some of these statements appear presumptive and assuming. This was purposely done so that respondents had to acknowledge and identify with each phrase, to consider the extent they agreed/disagreed with the statement and provide a measure by indicating a response on the Likert scale. Below are some examples taken from Appendix B, specifically, statements which corresponded to themes of ‘Landscape Appreciation’:

- 1) The landscape here in (PLACE NAME) has many local, historical, and cultural features.
- 2) During my visit to (PLACE NAME), I am able to feel closer to nature.
- 3) During my visit, I enjoy looking at the views of the surrounding landscape.
- 4) I enjoy visiting (PLACE NAME) more so than any other place.
- 5) I would like to visit (PLACE NAME) again in the future.

To ensure engagement, some statements were purposely negatively worded to make sure participants were both clear and able to acknowledge what was being asked of them. Hartley (2014) however, disagrees with this approach as some respondents can struggle to associate a numerical scale with a unique phrase, such as disagreeing with a negative statement rather than agreeing with a positive one, subsequently misinterpreting the scoring. Ideally, these scales would have been altered to reflect either the positively/negatively phrased statement, where higher numbers on the scale would correlate to positivity and lower numbers to negativity. On the other hand, there was a risk that this would have created extra confusion for the participant, so for consistency I did not incorporate this into the scoring system. Number 1 represented ‘strongly disagree’ and number 5 represented ‘strongly agree’. Consequently, the scoring system was not altered to match the manner of the statement, so an average value of ‘5’ consistently suggested that most respondents ‘strongly agreed’ with the statement regardless whether the statement was positive or negative.

It was also difficult to make the statements more generic for all participants. I noted that some responses did reflect and correspond to statements about visiting experiences, whereas for individuals who identified as residents either did not respond or answered indifferently. Instead, where these did not apply to that person, the not applicable (N/A) option ensured the provision of response and subsequent completion of the questionnaire. The Likerts also had to facilitate the calculation of an average value for collected responses, however, the averages calculated from the pilot data were often up to two or three decimal places in value. Putting the decimal ranges on the form was confusing, as respondents assumed that these were additional scales within each classification, to indicate the strength to which they agreed/disagreed (see below):

Original Likert Scale

N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0 – 0.99	1.00 - 1.99	2.00 – 2.99	3.00 – 3.99	4.00 – 4.99	5.00

Improved Likert Scale

N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5

To eliminate this problem, I changed the scale back to single figures and kept the classifications on my personal copies of the dataset spreadsheet, to help me determine the colour symbology and visual representation later.

Furthermore, I redrafted one of the more personal questions whereby I had asked participants to provide their postcodes as an indication of where individuals had travelled from to visit each of the cultural heritage sites. Some found this was a little intrusive because it would have been possible to search and pinpoint the specific neighbourhoods and streets that they had travelled from. Considering the ethical code and my responsibility as a researcher, to ensure both participant confidentiality and anonymity, I changed this to ask for only the first half of their postcode, being a more general area. This received more positive responses and was seemingly a more acceptable request to ask of my participants. When the data was manipulated into cartographic form and each location plotted, only the postcode areas associated to participants' places of residence could be traced, not their specific home addresses.

Similarly, to ensure participants remained at ease I made sure that there was always an option for participants to opt-out or pass on a question. Observed in the above Likert Scales, a neutral option was provided to reduce the pressure on participants, especially if the person was indifferent to the statement. Though these removed the binary format of a yes or no response, providing options like 'maybe' or 'unsure' meant that a response was always provided. These were useful in the piloting of the method as for questions that consistently gathered the vague, unsure opinions of participants, it highlighted the need to redraft questions for further clarity and transparency. Additionally, the questionnaire was used to frame the semi-structured interviews⁵¹ to acquire further details, depth, and understanding about the responses given. It was much more difficult to pilot these because each interview event was unique to the individual, the setting, their responses, emotions, and behaviours. I did however, test these with individuals I came across during the familiarisation visits and made similar observations to those noted in the questionnaire pilots.

Once each data collection tool had been deemed suitable for use, the research methods were repeated at each DCP, so that the collected data could be associated to each individual point. Specifically, this facilitated micro-scale comparisons between each of the DCPS at each site,

⁵¹ See section 3.3.4 Semi-Structured Interviews

as well as more macro-scale comparisons between each three research sites by aggregating the data to each location. However, it was not possible to carry out the data collection strategy at each of the three research locations in one day, so it was necessary to decide which days would be better suited to the investigation, i.e., which days would facilitate better chances of participant availability, the range of information, and provide the required data. In this case, Friday's were ideal for data collection at Esh Winning, Saturday was better suited for accessing Stanhope, with Durham being allocated to the Sunday. Each provided adequate opportunity to mingle with individuals in each location and provided enough time to collect both plenty of detail and relevant description from each location. I also replicated the methodology at three different times of the year. It provided opportunities to analyse the datasets and compare resulting trends and patterns across different time periods. For example, cartographic representations for Esh Winning could provide stronger indications of sense of place in the summer month of July 2017 than in the autumnal month of October 2016. The hypothesis and observations would then provide further motive for investigating reasons why and so on.

3.5.3 Sampling

My sampling process incorporated both quantitative and qualitative sampling qualities. I wanted to obtain as much relevant detail and description as possible, but still reinforce a level of confidence in my research methods, the collated datasets, and resulting data visualisations (Elliot & Timulak, 2005). In such cases, qualitative research does not rely on specific sampling sizes as a proportion of the target population to generate a representative sample. Instead, I tried to focus on making sure that as much in-depth detail and content was collected in response to the research questions and aims, whether the information be from five people, or fifty (Elliot & Timulak, 2005; Bryman, 2016). I found that qualitative sampling was a more flexible process that was able to collect a range of information from a variety of participants, being of good quality and intense description from a more limited number of sources (Elliot & Timulak, 2005).

Through temporal boundary sampling, the process incorporated the flexible quality of qualitative sampling and left the selection of units to my own personal judgement (Parfitt, 2005). My participants were therefore chosen based on who was available and willing to answer questions at each of the DCPs, outlined previously in the collection strategy (Parfitt, 2005). I did not set a desired population criterion. As it was only possible to visit one research location per allocated day, time was split between each DCP in chronological order. However,

if I felt that there was not enough data being generated at one specific DCP and potentially more useful and insightful data available at the next, I would move on to make the most of their time at that research site. In relation to the microscale, I did not need to tie the sampling to a specific geographical area as the research methods needed to collect information from predetermined points at each of the research sites.

The goal of my sampling was to make sure that all collected information was relevant to the overarching research question and subsequent aims. There was no need to generate a specific value for a target population as each member of that target population was unique to the area and corresponding DCP, for example, demographics (i.e., age and gender) or more simply the reasons for their presence in that location at that specific time. Though I still had a form of strategy and was selective of my DCP sites, I considered quota sampling as a type of purposive sampling that required me to actively find respondents in accordance with specific agendas (Parfitt, 2005). In this case, the quota sampling was loosely applied with location as the key criteria for recruitment, whereby the aim of the method was to ask any willing participants that were in and around each of the DCPs. It required me to, a) select the study areas from where a potential number of units will be available, these being the allocation of the DCPs as part of the collection strategy, and b) the setting of quotas or criteria within each setting, which in this case was any individual willing to contribute to the data collection (Parfitt, 2005). Doing so ensured that the resulting sample profile matched and facilitated my needs of the research investigation, to answer the research question with my motives at the forefront of the data collection (Elliot & Timulak, 2005; Bryman, 2016).

On the other hand, a limitation was no guarantee of a specific value of target population (Parfitt, 2005). There were no specific characteristics or criteria consciously identified for the sampling process, so a representative sample was not required. Instead, I collected as much data as I could from several participants, whilst the total population varied per site because of their differing size and scale. It meant that I could test my methods and techniques for thresholds, bearing in mind that they had to facilitate the visualisation process. I took advantage of a more flexible approach, whereby the information collected from any of the research methods could still be aggregated and sorted into specific categories as part of the data manipulation and analysis process (Elliot & Timulak, 2005; Bryman, 2016). Whether I needed to sort the information by research site, by temporal phase, or details collected in the methods themselves (such as indications of gender from the questionnaires), it was still possible to manage my datasets and digitise the data for use within the GIS software.

3.6 Data Manipulation, Analysis and Representation

This section of the chapter has two key purposes. The first is to provide an outline of the procedures used to prepare the data for later use and discuss some of the limitations associated to this process. Through the development and specific tailoring of the research methods, the corresponding techniques have enabled the quantification of qualitative information, whereby it has been possible to collect description, opinions, and observations, in efficient and effective manners. The manipulation and digitisation were then required, prior to implementation of data representational techniques and visualisation. The second is to identify the various analytical approaches used within the investigation, and my approach to the coding, sorting and categorisation of information.

Following the data collection, the purpose of GIS was to utilise its capability for handling the large quantities of collected data, to process and analyse both quantitative and qualitative information (Aitken & Kwan, 2010). The subsequent analysis conducted by GIS is predominantly spatial, to explore the emerging patterns and trends in relation to place, location and setting. As part of my qualitative GIS approach, the integration of the data types could only begin once I had started and finished the preparation and digitisation of information (Elwood & Cope, 2009). Though there are variety of methods and approaches to consider, there is no unique specification that determines the right or wrong way to do so (Punch, 2005). This section will identify the various analytical approaches acknowledged in this methodological process (i.e., thematic analysis, computational analysis, and grounded theory analysis), justifying their use within the research investigation to facilitate the resulting data representations. Specifically, the section will observe how it was possible to associate with not just one method of an analysis, but instead utilise the motives and strengths of several to enable the visual representation of qualitative information. It will outline the analytical techniques used to transform various levels of qualitative information into quantitative formats, for processing into different types of visualisation.

3.6.1 Manipulation and Digitisation

In the case of this research investigation, the data manipulation process involved processing the paper-based records into software packages like Microsoft Excel and Word. These included all completed copies of questionnaires, handwritten participant observations and interview accounts, and the audit surveys collected at each DCP across each research location. It required formatting collected data into tabulated formats ready for the initial analysis, such

as calculating the average scores from the Likert Scales and aggregating responses provided by participants. This process enabled the information to exist in what Elwood & Cope (2009:6) terms ‘code space’, whereby the data could be represented and visualised for interpretation through some form of GIS (Schuurman 2006). It required applying a necessary level of ‘fixity’ to the qualitative information through numerical representation, though these are not representational values (Elwood & Cope, 2009). The numerical associations are primarily used to process information through a software package or GIS for analysis and/or visual representation. It is a method of integrating qualitative data with geospatial technologies, to create and use spatial data and spatial analysis to present new geographical knowledges.

Numbers are a necessary part of language and are often used to symbolise factors in non-alphabetical ways (Kirby, 2003). However, writing with numbers is not just about code, algorithms, and computational equations. They can be used to represent humanistic behaviours, experiences, and activities, which subsequently allow myself and other researchers to read society like pieces of ‘text’ (Kirby, 2003:417). Social media is an example of this regarding individuals who use various social media platforms turn their daily lives and reality into forms of data, by communicating and sharing various information through digital communications (Gkatziaki, *et al*, 2017). Specifically, when a person ‘checks-in’ on Facebook or uses a geotag on Twitter, they unknowingly turn their experiences into some form of code space, contributing to vast quantities of data by pooling it into enormously sized databases (Elwood & Cope, 2009; Gkatziaki, *et al*, 2017). It provides information about social interactions, activities, and how these individuals move in and around both physical spaces and society. This quantification of information is a concept I have encompassed in the construction of my mixed methodology. The methods themselves use numerical representations to collate qualitative detail and aggregate it to specific geographical points, ready for spatial analysis and visualisation. Fotheringham (2006, cited by Aitken & Kwan, 2010) argues that any form of quantification has a primary focus to contribute to better understandings of space and develop new knowledge about spatial process. However, the numbers alone cannot provide the additional depth, deeper meanings, and understandings that narratives of written words, description and detail can (Kirby, 2003; Aitken & Kwan, 2010).

Through various technologies and computer software packages, there is an increasing capability for digital tools to collect qualitative information, to use as either the main form of exploratory power for research or as supplementary detail. Jung (2009) however suggests that

even after the data has been manipulated in digital formats, like Excel spreadsheets and other tabulated forms, it is worth noting the potential benefits of using datasets that are untouched and still in their originally collected form. In this research project, the digitisation of material came with the limitation that not all relevant detail would be transferred across into the new technologically based formats, therefore implementing a risk that relevant and necessary depth, and meaning could be lost in the transformation process (Jung, 2009). I had to compromise as to visualise information and create new representations of data, it was essential to input my data into formats that the computer and GIS software could read and process. Any corresponding patterns and trends that were revealed in the representational process could be supplemented by other sources of data. Consequently, I was able to enumerate reality in a way that facilitated the visualisation of people's interpretations of landscape, using numbers as a form of computational language (Kirby, 2003; Gkatziaki, *et al.* 2017). I had to bear in mind that although it was possible to conceptualise a GIS, to what cost and extent has the research utilised this approach to enable a better more exploratory understanding of spatial trends and patterns?

3.6.2 Identifying the Analysis

Narratives and oral accounts of experiences, observations and perceptions can provide rich detail and context that is valuable to providing description and insight into the stories that individuals have told. Whether collected from participant observations, interviews or questionnaires, the resulting analysis was based on my interpretations, to sort and place the data into various segments and groups (Punch, 2005). As part of a thematic analysis, I categorised and sorted information into relevant themes, and identified where others did not. I acknowledged Ryan & Bernard (2003) regarding how best to locate and sort my information: a) were there topics seemingly repeated throughout the piece, b) was there evidence of local jargon and typologies, c) were there examples of metaphors, similes, or analogies used by participants, and d) was there any information missing? This analytical approach meant that I could come up with a list of themes and subthemes that I had discovered within the analysed text (Bryman, 2016). It ensured that my material was placed under scrutiny and done so thoroughly, so that key themes and subthemes could be identified prior to more rigorous analysis and testing. However, my analytical process did not solely depend on the identification of themes. It also required searching for key pieces of text that could provide evidence of those identified concepts and sorting them into the corresponding categories.

Observed previously regarding grounded visualisation⁵², grounded theory is another well-known framework used to analyse a variety of qualitative information. It is a series of procedures that takes key pieces of evidence, groups, sorts, and organises it into distinct categories, to enable the comparison of various data types (Walsh, *et al.* 2015). In this investigation specifically, I do not push for a grounded theory *per se*, but instead utilised certain tools of the analytical approach to facilitate the representation process. For example, the coding of material discussed in the next section, involves splitting and sorting the information into relevant categories or ‘components’ determined by the data itself (Bryman, 2016:573). It recognises the overview of themes noted in the initial index of topics and finds evidence to support their recognition, i.e., evidence relating to attachment to place, landscape appreciation, and so on. It required constant comparisons throughout the analysis, observing the links between the evidence and the themes that are highlighted in the text (Bryman, 2016). Doing so ensured that I was aware of the relationships between various pieces of evidence from a variety of the data sources, to make sure I was consistently aware of the phenomenon beginning to emerge from the datasets. For example, landscape appreciation began to appear in the data analysis much more strongly at some DCPs but not necessarily at others, prompting the motivation to investigate why. I could then consider how best to present the trends and patterns visually through various symbolisations and associate the necessary spatial context to create cartographic representations (Steinberg & Steinberg, 2005).

The analysis conducted by GIS was predominantly spatial to investigate phenomena in relation to place across a defined geographic scale and create resulting cartographic data representations to present the findings. Being a computer-based piece of software, the methodology observed computational analysis, an approach used to observe and interpret material after the initial digitisation of qualitative records via specific technological tools. The collected information was inputted into a variety of software packages and placed under further scrutiny, often referred to collectively as a Computer Assistance of Qualitative Data Scheme (CAQDAS) (Punch, 2005). These software packages are primarily a helpful tool and analytical aid for pulling out the trends and patterns from within qualitative data (Punch, 2005). For this investigation, the chosen CAQDAS was NVIVO due to its compatibility to fit the needs of the analysis, ease of use, and availability of handbooks and guides. NVIVO allowed me to insert various files and documents (i.e., Word files of interviews and participant observations) into the programme, ready for coding and categorising under a series

⁵² See Chapter 2.0, section 2.3.2 Grounded Visualisation and Knigge & Cope (2006, 2009)

of 'nodes' (Bryman, 2016:605-606). Like the categories and components mentioned earlier in grounded theory analysis, the splitting and sorting of information into groups through NVIVO was a similar process, though evidence was categorised by colour under a corresponding node. These nodes were then arranged into a hierarchy with one overarching theme and several subthemes, i.e., 'landscape' and was made up of three sub-nodes, 'appreciation', 'satisfaction', and 'symbolic and historical'. To understand the formation of nodes and categorisation of key evidence, I will outline my approach to coding qualitative data in the next section, including how I used CAQDAS to support the data visualisation, by combining its tools with GIS techniques.

3.6.3 Coding

In this investigation, coding was used to provide a measure of how many times a specific concept or theme appeared across the range of data sources. These values were therefore representational of quantity, being the quantity of evidence under a specific node, with the potential to be processed and presented through some form of data representation. Though the investigation was not looking to ground theory within the data, ground theory analysis provided a guide on how to approach the coding process, recommending that it must be flexible and accommodating of change whereby new themes may become apparent from within the data (Bryman, 2016). As indicators of specific concepts, the process of 'open coding' material enabled me to scrutinise the datasets and pull-out key pieces of evidence (Strauss, *et al.* 1990, cited by Bryman, 2016:574), to conceptualise and categorically sort highlighted evidence into identifiable categories or nodes.

A limitation of the coding however is that the results for each series of nodes and hierarchy of categories is entirely down to my discretion (Bryman, 2016). There was a risk of losing vital fluidity and context that was recorded in the narratives, by splitting the interview transcripts and participant observation records into various fragments. By removing evidence from the social context in which discussions were conversed and communicated, the qualitative detail like emotion and noted behaviours was lost because the information was transformed into a simple numerical representation. However, rather alike Jung (2009), it was possible to reflect upon the context of the datasets, to ensure that there was still a level of detail and depth associated. Bearing this in mind, the section moves on to discuss the integration of NVIVO and GIS, outlining their key uses, similarities, and adoption of a computational analysis approach.

3.6.4 NVIVO and GIS

NVIVO and GIS are two programmes that require a highly visual approach to analysis and subsequent data representation (Aitken & Kwan, 2010). Specifically, NVIVO enables users to visualise categories of themes and concepts that have appeared from within the datasets, observing the links between various nodes and where themes may have become more evident in the narratives of participants (Bryman, 2016). As a representational tool, GIS also enables the user to visualise information, specifically in relation to spatial context, by observing the identified trends and patterns across specific spatial scales (Goodchild, 1995). GIS can present visualisations of geographic objects (i.e., roads, settlements, and land topography), but it can also include ontological information, possible through attributes relating to specific, corresponding files via a database, or more simply a table (Jung, 2009). Using the GIS software ArcMap, I produced shapefiles that represented each category of data, each containing a table of information about associated features. When I corresponded these to a determined symbology, I was able to produce various forms of data visualisation. For example, land use can be determined by colour classifications and an associated key, population size can be determined by the size of a point and associated to a specific key and scale. This section will discuss the combining of the two technological tools through a computational analysis approach, to facilitate the processing of qualitative detail into cartographic forms. It observes the links between identified nodes and spatial context, to consequently view the geographical trends and patterns from within the qualitative datasets.

The following examples demonstrate a tailored form of analysis by combining NVIVO and GIS. The first example is the CAQDAS coding of 'landscape' through the NVIVO software, to create one specific node that categorised evidence associated to one specific theme. In Figure 10 below, the 'landscape' node consisted of three sub-nodes, 'appreciation', 'satisfaction', and 'symbolic and historical', to enable a quantification of concepts interpreted from the analysed material. This data was aggregated to corresponding DCP points and processed into various forms of cartographic representation.

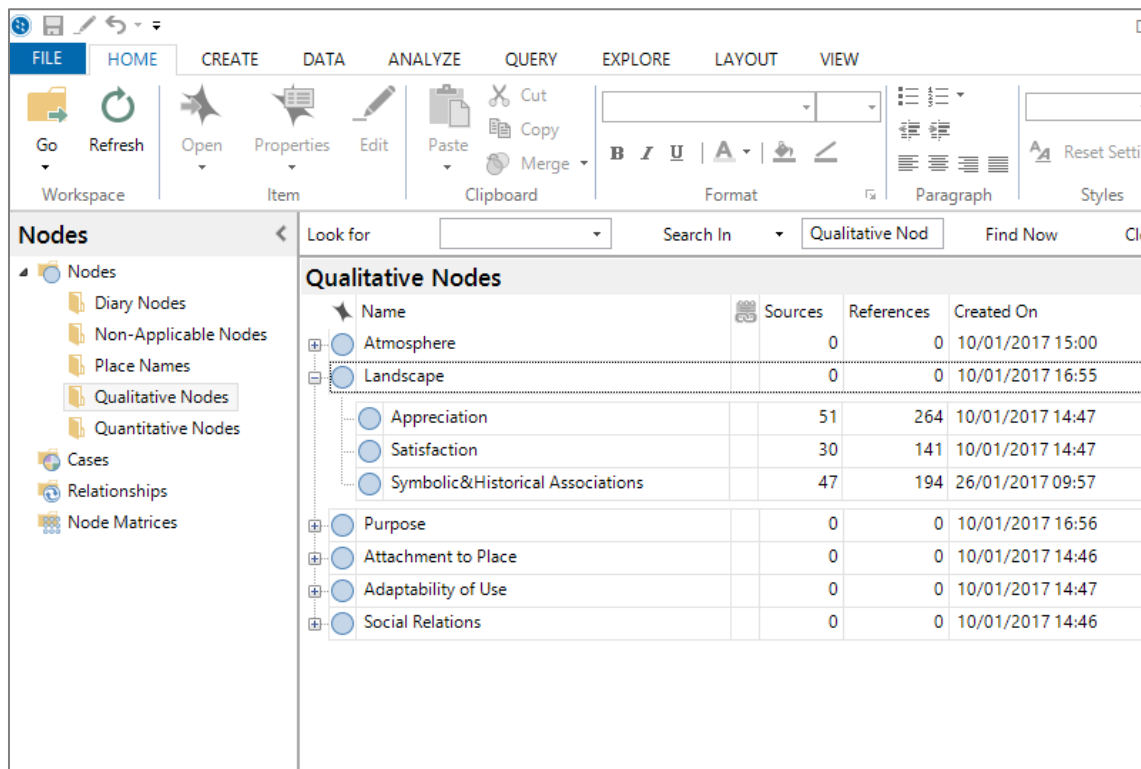


Figure 10: The Landscape Node in NVIVO 11

The second example used NVIVO to determine placename frequencies and GIS to plot the results; alike Cooper & Gregory (2011)⁵³. In this investigation, certain landmarks, monuments, and placenames were highlighted in the coding process and aggregated to DCPs, providing an indication of word frequency across each research location.

The integration of these tools has emphasised the analytical capability of both grounded theory analysis and computational analysis approaches, using their primary focus to search for patterns and trends from within specific datasets and observe the relationships between people and place (Goodchild, 1995; Steinberg & Steinberg, 2005; Elwood & Cope, 2009). The findings themselves, however, remain subjective and open to interpretation (Elliot & Timulak, 2005). Researchers like Aitken & Kwan (2010) question the capability of GIS to both handle and analyse qualitative information, specifically, whether it can create new knowledges through representations of human understanding, emotion and meaning. This research argues that there are methods of doing so. Identifying key themes and concepts from within qualitative data to visualise them in relation to their spatial context, provides additional opportunities to integrate a variety of data sources through technological tools. Furthermore,

⁵³ See section 3.3.5 Secondary Data and Cooper & Gregory's (2011) work on 'Mapping the English Lake District: A Literary GIS', which is discussed later in Chapter 5.0

the following chapters will provide additional evidence to support the capabilities of GIS, observing a range of visualisation techniques created to present qualitative spatial data.

3.7 Ethics and Risk Assessment

Regarding ethical conduct, confidentiality, and anonymity, I wish to outline and disclose the steps taken to ensure participant identities could not be pinpointed by other individuals at any point following the data collection.

The questionnaires were sorted by area and DCP, numbered sequentially in order of completion and categorised by temporal phase (this being the period of data collection). Observing Appendix B, each questionnaire contained a participant information sheet prior to the completion of the questionnaire that outlined the aim of the method, its purpose, and how both the participant's identities and data will be managed and kept anonymous. It provided further reassurance of an opt-out option that if any participants wished to stop with their contribution, they could do so, and all information destroyed. There is also a disclaimer stating that no further contact will be made by either myself or the university, ensuring I could adhere to the university's ethical code of conduct (Newcastle, University, 2015). Additionally, more personal questions that asked for details about the participant were asked at the very end of the questionnaire, though there were no specific records of names, ages, date of births, addresses or contact details requested. No sensitive personal data was collected.

Interviews were also asked of the participants. Each one was coded by area, DCP, and categorised by temporal phase. No personal details or descriptions were noted, other than minor details that aided in recollection of the interview, such as, 'dog walker', 'couple', 'young woman with a buggy'. For anonymity, individuals were denoted by a capitalised letter of the alphabet and no specific characteristics or traits mentioned (Valentine, 2005). Data was initially digitised, all paper records boxed and filed away, then locked in a secure cupboard that only I had access to. Once digitised, data was processed, sorted, coded, and analysed into various aggregated results, for transforming into data representations via symbolisation. These records are currently kept on a password protected hard drive, whilst any back-ups and copies are also stored on a unique, restricted access computer, made further secure by additional password protection. Subsequently, all recorded data had to be relevant to the research investigation, used for the research investigation only, processed fairly and kept safe (Newcastle, University, 2015).

3.8 Concluding Comments

The aim of the research is to critically assess the capabilities of data visualisation to present and communicate complex, qualitative datasets. By considering the strategies and techniques to do so, this research has been able to devise a methodology that can capture the interpretations and perceptions of individuals within specific heritage settings, to create more qualitative forms of cartography.

Data visualisation can do more than just produce visually pleasing illustrations and charts, and present the narratives from within data (Yau, 2011; Dorling, 2012). They have expanded and developed to include the subjective detail and description associated to qualitative data types, to enable researchers to better understand the societal and cultural contexts associated to behaviours and response (Segel & Heer, 2010; Yau, 2011; Jeannotte, 2016). However, whilst data representations may be beneficial and provide additional context to understand phenomena, researchers need to know how to do so. As this research observes the relationships between people and place, it queries how people develop connections with cultural heritage sites using data representations to effectively communicate and visualise associated subjective and intangible factors. The methodology therefore required the development of tools and techniques to facilitate the visualisation. Consequently, I have developed an integrative mixed methodology through a qualitative GIS approach, using a variety of methods and techniques capable of quantifying qualitative detail to enable the digitisation, manipulation, and transformation of data into the required visual form.

With cartography at the forefront of this thesis, I argue that data visualisations can be more than an investigation's product of necessity. By carefully planning and identifying the required data and types, the relevant collection methods, and strategy, I have been able to consistently integrate a spatial quality throughout the methodological process, to consider the manipulation, analysis, and representation of data in cartographic form. This sequential approach has subsequently guided this thesis and resulted in the amalgamation of several conceptualisations and frameworks. Researchers can tell more meaningful stories with their data by engaging with data collection, manipulation, and representation processes, hence I propose that it is necessary to acknowledge newer techniques for visualising data. By doing so, researchers are better grounded in the theoretical and analytical approaches required to understand identified geographical themes of research. This includes the conceptualisation of GIS and a qualitative GIS approach, the motivations for data visualisation and the various chart types, and finally, the conceptualisation of landscape as a palimpsest (Wylie, 2007)

being both the object of an investigation and a process to make sense of the representations engrained within.

Notably, qualitative GIS has its own challenges. A number of these have been referred to and outlined, however I argue that certain considerations need to be continually acknowledged to try and resolve/reduce the implications. The manipulation and categorisation processes bring a high risk of relevant and important detail being removed from data files. Unfortunately, it is not easily resolved though I have taken strategic action as a form of compromise. Specifically, by combining methods through the mixed methodology, acquired datasets can support emerging relationships and correlations by collaborating rich sources of context and filling in any necessary details (Schuurman, 2009). GIS can hold ontological information using attribute tables, so whilst information may be held in some form of data file (i.e., shape or point), the relevant information can still be linked and saved to the digital file (Schuurman, 2006; Jung, 2009). Additionally, generalisation is also an issue specifically regarding the spatial scale of information, which I have attempted to resolve through this micro-scale research project. More specifically, I have collected data from precise geographical points across each research site, rather than aggregate information by location. By doing so, I can aggregate information later and keep the necessary details associated to corresponding geographical points for plotting and consequent visual analysis (Knigge & Cope, 2006; Jung, 2009).

Both my qualitative GIS approach and the GIS software brought further issues regarding the quantifying of qualitative data. It took time to develop methods capable of recording detail in more accessible formats. I had to research methods that could record and provide a numerical measure of qualitative detail, using numbers to represent information and there are limitations to reiterate regarding this. The numbers do not correspond to representative number values, they are used primarily to associate a symbology and cannot be used for statistical testing (Kirby, 2003; Aitken & Kwan, 2010). Furthermore, time issues extended to the paper-based methods, which required manual digitisation into some form of computational software. The GIS programme requires numerical formats, so it was essential to sort, group and manipulate each and create a form of 'code space', whereby my datasets could exist for selective manipulation and transformation (Elwood & Cope, 2009:6). In future, I would consider hand-held technological tools that can collect, process, and digitise information with one use, rather than having to perform the lengthy transcription, digitisation, and categorisation process. GIS

was, however, able to incorporate data from other forms of computational software (i.e., NVIVO), making my approach a more inclusive and reflexive process.

There are issues that this thesis has not been able to accommodate. Regarding its place within human geography, GIS is predominantly a tool rather than a science because it is first and foremost a quantitative resource (Pavlovskaya, 2009a). However, GIS does have a growing strength and capability to associate with more qualitative research projects, allowing researchers to utilise a spatial quality and consider a spatial analytical approach to their collated qualitative data. It requires the experience and knowledge to understand GIS as a science, but it can produce its own concepts to assist with further geographical enquiry and contribute resulting knowledges (Pickles, 1997; Longley, 2000, 2005; Elwood & Cope, 2009; Boschmann & Cubbon, 2014). Moreover, I have provided evidence that GIS can investigate more humanistic phenomenon and concepts, incorporating both the quantitative and qualitative relating to geographic lines of enquiry. The following chapters provide examples of how I have best utilised my mixed methodology and considered GIS not only for its technological capabilities, but its potential to assist researchers with their various studies and investigations.

I have outlined and justified the choices made to devise a mixed methodology suitable for this research project. I therefore conclude that this methodology has been successful and move to introduce the following three chapters, Categories, Charts and Cartography, Mapping Relationships, Patterns and Flows, and Experimental Mapping Categories. Each explores a range of data visualisations and presents new qualitative forms of cartography, assessing their capability to integrate the quantitative and qualitative and present the complexities between people and place. These are analysed and interrogated regarding their design, purpose, and degrees of functionality as forms of data representational, with a discussion framed to reflect on their ability to communicate such knowledges.

Chapter 4.0 Categories, Charts and Cartography

4.1 Stories and Data

The motive for storytelling with data is to find out what data has to say about identified factors and variables, looking beyond numerical figures and statistics to observe snapshot representations of real-life phenomena (Yau, 2011). Using ‘visual space[s]’ to present information, data visualisation is arguably the best way to find the patterns from within collected datasets (Yau, 2011: XVI). The brain can observe and identify patterns, correlations, and anomalies much easier than through Microsoft Excel spreadsheets and document tables. With this motivation, the thesis will develop new types of qualitative cartography, considering data graphics and cartography under the same umbrella term ‘data visualisation’. By revisiting and examining more familiar representations of quantitative data, it is possible to consider the various strategies for producing qualitative representations. Doing so provides initial considerations for how to best to present information through clear and effective formats, and the techniques required for quantifying detail into relevant groups or categories for processing. The purpose of the empirical chapters⁵⁴ is to therefore explore the possibilities of integrating the quantitative and the qualitative, the digital and non-digital technologies, to produce qualitative cartographic representations. These subsequent representations can tell more in-depth, detailed, and descriptive stories about geographical concepts, such as landscape perception.

The aim of this chapter is to explore methods for collecting qualitative data and implement a technique for quantifying qualitative information. This will subsequently enable the representation of qualitative data cartographically. First, the following section will revisit ‘categorical charts’ providing a brief overview of this chart type (Kirk, 2016), in relation to the grouping and sorting of data into pre-defined categories of information, examining ‘land use maps’ as a method for categorising and representing data about the environment. Secondly, the chapter will critically assess a method for ‘measuring’ qualitative data and quantifying records into suitable categories for computational processing. Known as ‘audit surveys’, this assessment considers how to capture and record landscape perception, in relation to the thesis focus on interpretations of cultural heritage sites. Doing so facilitates the creation of ‘audit maps’, designed to be used as supplementary representations for exploring

⁵⁴ This refers to Chapters 4.0, 5.0 and 6.0.

how space is used, people's experiences at cultural heritage sites and the relationships between and place.

4.2 Mapping Categories

Categorical charts⁵⁵ are designed to present pre-defined groups of information and associated quantitative values, using either nominal data which is qualitative and sorted into groups of information as counts (i.e., gender, hair colour or blood type), or ordinal data which is also qualitative and characterised by order or rank and grouped at specific intervals (i.e., on a scale of one (strongly disagree), to five (strongly agree)). A key role of these data visualisations is to present data clearly for findings and conclusions to appear from the data representations (Yau, 2011). The thesis will extend the motives of categorical charts to create various categorical maps and examine methods for categorising qualitative data into more manageable quantified formats. To do so requires associating a spatial reference by either aggregating information around a specific set of co-ordinates or grouping categories of data to geographical boundaries.

Looking at land use maps specifically, this chapter considers these cartographic representations as part of categorical mapping⁵⁶ with an ability to identify the locations of categories and interpret corresponding spatial patterns of data. They provide visual representations of land function through aspects of symbology, by describing the intended purpose of specific areas of land (Cihlar & Jansen, 2001). The section will examine and assess the approach and techniques required to create land use maps, to understand the design process needed to quantify and categorise information for representation. It will discuss the considerations required to classify and symbolise categorical data and observe the contested nature of developing effective map legends with suitable colour symbology. As a form of spatial data visualisation, land use maps are a consideration for presenting categories of information whilst engaging with various debates that apply to the representation of qualitative data. The chapter will then critically assess audit surveys regarding their function and ability as a data collection method, to quantify qualitative data into desired categories or themes. They are an approach to 'measuring' people's responses to physical space (Harvey & Aultman-Hall, 2016), using a conceptual framework for observing landscape perception

⁵⁵ See Chapter 2.0 section 2.3 Visualising Data

⁵⁶ To differentiate between categorical mapping and charts, categorical maps illustrate patterns of different land use with a purpose to inform about the physical environment. Categorical charts would enable the user to create a chart with the x-axis showing different land use types and the y-axis showing the frequency of corresponding land use types, to compare frequency of land use categories.

(Ewing & Handy, 2009). The chapter will present three maps designed to present data collected from the audit survey, and critically assess their ability to communicate information about the environment and associated reactions and responses of individuals. These are designed as supplementary representations for people's experiences at cultural heritage sites and their relationships between and place. Users can deepen their understanding of phenomena from a more geographical perspective by visualising trends and patterns in relation to space and place. Consequently, these visualisations can be highly useful exploratory methods and as this chapter will argue, they provide the first incentive to present qualitative data cartographically.

4.3 Land Use Mapping

Viewing land use across specific locations can provide further context to explain and suggest reasons for occurring phenomena. In this research study, land use maps were used as an exploratory tool to make observations through secondary, categorical datasets, downloaded from a variety of online sources including Edina Digimap and the UK Data Service. Specifically, I used land use maps to observe primary land use purposes at each of the three research sites, to look at a variety of levels of land use (secondary, tertiary, and mixed-use) for background research and context. My focus was to see whether the predominant land use identifiers were reflected in the motives of individuals, i.e., residents that stated they were out shopping in their local area would be supported by indications of predominant commercial land use. I also considered the representational possibility of presenting qualitative data through categorical mapping processes. However, 'land use' is as it is often confused with the term 'land cover'. Both are used to describe the environment but regard two different aspects: one in terms of describing humanistic processes (Cihlar & Jansen, 2001), and the second in terms of acknowledging the natural world. To differentiate, the paper will use Cihlar & Jansen's (2001) definitions to clarify:

- Land Cover (LC):

'Land cover' is classified using a system of discrete series, to characterise various 'biophysical features of the terrestrial environment' (Cihlar & Jansen, 2001:275). These include artificial surfaces, forests, wetlands, bodies of water, and so on (INSPIRE, 2012, cited by Mildorf, *et al.* 2014). Figure 11 provides an example of land cover for Oklahoma, US, using nine discrete classification series to indicate different types of land cover, including 'forest and woodland', 'open water', and 'semi-desert'.

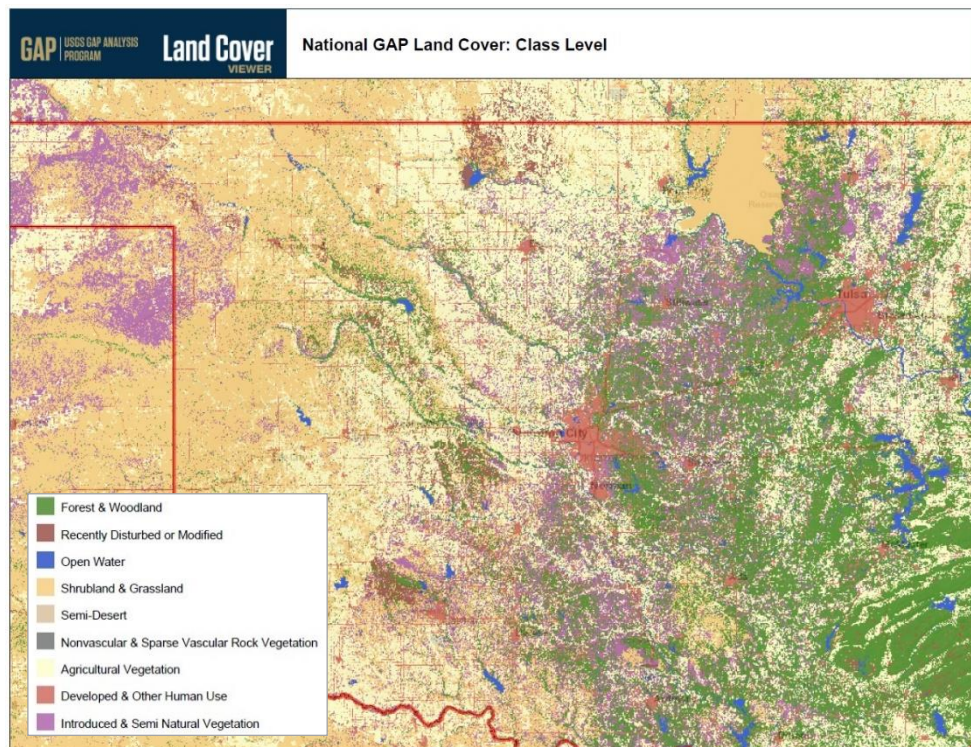


Figure 11: Land Cover of Oklahoma, USA
(US Geological Survey, Gap Analysis Program (GAP), 2011)

- Land Use (LU):

‘Land use’ on the other hand, refers to the ways that these ‘biophysical’ elements are used by people, and describe the intended purpose of specific land cover areas (Cihlar & Jansen, 2001:275). To clarify, the LC would identify large open bodies of water within their cartographic representations, whilst LU would identify the purpose and use as a reservoir. Figure 12 below from Koks, *et al.* (2015), recognises eleven land use classifications used to indicate specific land functions, such as residential, public, commercial areas, and so on.

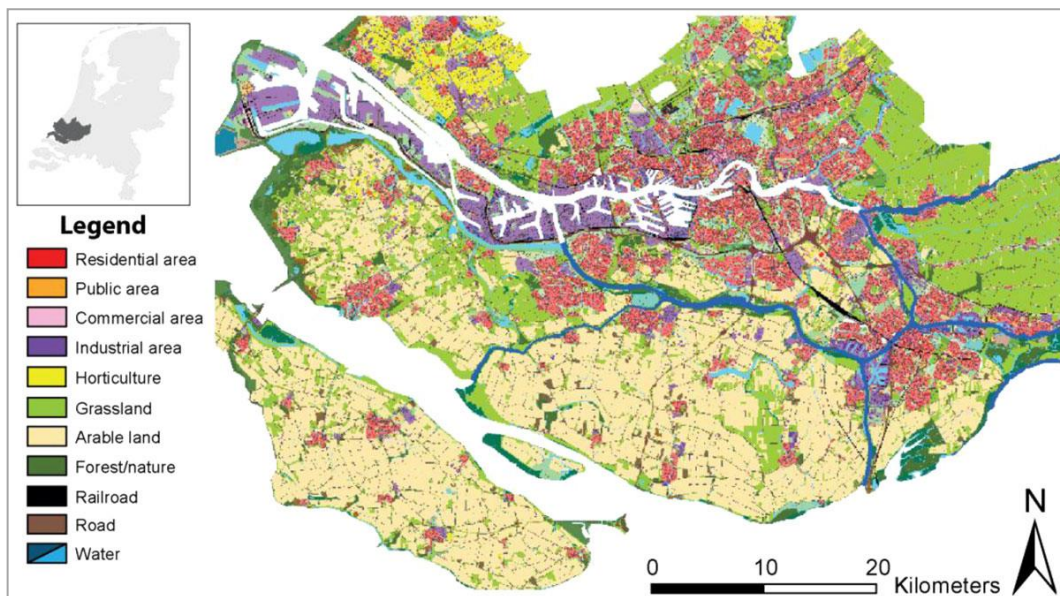


Figure 12: ‘Land use map of the greater Rotterdam area’

(Koks, *et al.* 2015:11)

The close relationship between LC and LU often leads researchers, practitioners, and professionals to confuse and combine the uses of both within the creation of their maps (Treitz, *et al.* 1992; Cihlar & Jansen, 2001; Mildorf, 2014). In some cases, it is intentional. LC maps can provide an indication of environmental characteristics associated to specific landscapes, to acquire further information about specific heritage landscapes, such as forest-based areas (like National Trust estates and parks), or a part of various water systems (like the UK’s canal systems). LU maps on the other hand provide further description and can pinpoint either prior or existing intended purposes of identified areas of land. The cohesive and beneficial combining of LC and LU maps enable users to uncover more from the visual representations and provide further information for supplementary use. In this thesis, I will refer explicitly to LU mapping to support the link between categorical mapping and the presentation of categories of information by geographical location.

4.3.1 Applications and Implementations

The following discussion provides examples of the application and implementation of LU maps, outlining their use and the further context that both supports and fuels geographic enquiry. In doing so, the chapter can support and highlight the potential that categorical maps have for presenting categories of qualitative data.

The first example relates to old industrial landscapes characterised by both the type of industry established and the surrounding settlements built to house the residing population.

Areas used for mining, for example, will have undergone change due to the extraction of minerals and ores affecting characteristics relating to the natural, physical environment (Antwi, *et al.* 2014). LU mapping can assist in the examination of these areas by acknowledging the present purpose of specific environments and identifying clusters of residential zones (i.e., settlements) associated to the area's industry, using satellite imagery to identify corroborating features upon the landscape such as small spoil heaps, discontinued railway lines, and quarries. Doing so would provide evidence to highlight potential historical links between the environment and surrounding settlements, such as understanding the development of small rural settlements in response to industry and population growth. These maps may also highlight how this activity has contributed to both the natural landscapes and heritage sites observed today, and the supposed values engrained within landscape markers and monuments as representations of culture, history, and heritage (Rich, *et al.* 2015).

Considering heritage management and environmental risk assessment, LC and LU maps can also be used to plan and prepare for the future. In China, there are increasing pressures on flood management and risk assessment to protect cities situated along various rivers, and deal with issues of urbanisation and a rapidly increasing population (Yu, *et al.* 2016). As part of their study, Yu, *et al.* (2016) used LU maps to assess land use change and observe the locations of small cultural villages. They considered potential future land use changes within the spatial context of small settlements, and highlighted areas under conservation that would not be permitted to change (i.e., specific forests and grasslands). It meant that they could produce a risk assessment map to see which cultural settlements were at a higher risk from urbanisation processes, whilst also making sure that protected areas of forest and grasslands could not be used for agricultural purposes. It suggests that a 'real life aspect' could be represented into some form of cartographic representation (Yau, 2011), using specific time frames to predict future situations and secondary data to understand the link between human activity and landscape. By identifying features and describing their purpose, these maps can supplement and contribute towards an interpretation of landscape and facilitate understandings of the relationships between the physical environment, people, and place.

On the other hand, LU maps are susceptible to external influences, such as cultural factors, economic motives, and time (Treitz, *et al.* 1992; Cihlar & Jansen, 2001). For areas that are consistently changing and subject to rapid developments, LU maps can quickly become inaccurate and outdated (Treitz, *et al.* 1992). Economic motives are often linked to various policies, subsidies, trade links, and the production of goods for exportation, whereby these can

greatly influence a country's agriculture and subsequent physical environment (Jansen, 1990; Jansen, & Di Gregorio, 2003). They become non-representative of the present time but are still useable as accurate resources, such as historical documents to observe temporal change (Treitz, *et al.* 1992). Consequently, LU maps may be framed with a specific agenda or motive, to represent a specific point in time. Land use classifications are only useful for the period the map was created in, meaning there are other external factors to consider and additional context to observe, i.e., reasons for the occurrence of change. These limitations also apply to qualitative cartographies and are exemplified further when dealing with people's opinions, behaviours, and responses. Though the methods of data collection may be replicable, the results are not and are dependent on participant positionality, circumstance and other external influences including the physical environment. I argue however, that LU maps are still a useful exploratory tool for providing further context about specific geographical locations, though are consequently a product of specific design specifications, research requirements, and collated datasets.

The following section will discuss my engagement with the design process associated to creating a LU map, the use of LC maps as a supplementary resource for background content, and the limitations/constraints that can and did arise within my investigation. Titled, 'A Contested Key', I also discuss the development of an effective map key for representing categories of land use and engage with key debates surrounding the colour symbolisation in cartographic representations. Though I do not provide research related examples in this section, I do present an audit map design later that uses land use mapping to describe the environments around one of the three research locations.

4.3.2 Designing a Classification and Symbolisation

My investigation began with making sure the design specification for a LU map met the requirements of the research, and my needs as an exploratory tool for data visualisation. The LU maps were designed and created using GIS hence it was important to recognise that the data sources themselves needed to be both of decent quality and complete (Welch, *et al.* 1988, cited by Treitz, *et al.* 1992). I began by compiling several individual data layers to stack and overlap on top of one another to create one visual representation. For example, LC maps often use satellite images to pick out and classify various land cover types, so I used them in a similar way to construct the LU maps. I accessed, manipulated, and applied additional boundary data and mapping layers like ordnance survey, to create a better image of each

location. It helped identify various built environments and indicate various types of landscape, which were then assessed regarding function and purpose.

This approach had great potential for error where if the same mistakes and flaws were made throughout the compilation of each of those data layers, it would risk validity and replicability at the data analysis stage (Treitz, *et al.* 1992). There were also issues and limitations throughout the data compilation process, including technological issues (i.e., pixelated images and incomplete datasets), as well as other external factors like economic motive (i.e., the cost of data). With these constraints in mind, I acknowledged Cihlar & Jansen's (2001) motive to use LC maps primarily as a supplementary resource; to assist with the development of the data representations and maximise the potential for LC maps to contribute to the creation of the LU maps. Doing so required following a tripartite, chronological guide that framed the overall design process observed next:

- a) the re-examination of the classification system to ensure the resulting map key was both suitable and applicable for representing data from the research project,
- b) the interpretation of images, whilst contextualising information based on additional visual analysis and recognition of boundaries,
- c) the addition of variables for further context, such as contour lines, terrain attributes, and/or geological layers (Cihlar & Jansen, 2001:283).

The Design Process

The first stage of re-examining the classification system required considering which land use categories were appropriate for data representation. If any were deemed unsuitable, I had to come up with a series of specific criteria to develop my own classification system (Brabyn, 1996). Walde, *et al.* (2012:122) provided an example through urban land use modelling, using only six classes to aggregate identified land use:

- 1) the city centre, referring to continuous builds,
- 2) residential, single family houses, being small, detached properties,
- 3) residential block building, being larger rectangular buildings like high-rise flats,
- 4) industrial areas, being isolated blocks of buildings with 'simple form',
- 5) allotments, being areas of vegetation and much smaller detached outbuildings,
- 6) the administrative district, being larger buildings in complex forms, typically isolated away from the city centre.

Though simple, the classes themselves were not so easy to define and risked issues where the criterion would not allow for clear indications of mixed-use. Instead, I allocated purpose based on the more predominant use of the land and utilised secondary sources alongside fieldwork visits, to ensure accuracy and verify the classifications devised each site. The classification list could only be designed based on what information was available, so the criteria for constructing a classification list resulted in a key unique to each area (Brabyn, 1996). The classifications and legend key also needed to be replicable across several locations. This PhD has three research locations specified so each map needed to have key that was transferrable across each site, to keep the cartographic representations consistent and clear for comparative viewing. Consequently, where a classification was not identified at either of my three research locations, I did not include it in the key for that corresponding map. This issue of replication was also apparent with existing secondary datasets, where the land use classifications were pre-set for a specific corresponding research project (Goetzke, 2011, cited by Goetzke, 2014). I found it difficult to replicate one person's classification system designed to meet their specific research specification, onto my own project of an entirely different calibre. In the case of this research, pilot tests and initial notations were made at each of the three research sites, including observations regarding the land use. This was to make sure that any sourced information was indeed correct, and any alterations could be made. Furthermore, I found that when developing the land use classifications, the resulting classes were dependant on the scale of the project; whether observing groups of buildings and looking at generalised land use zones or looking at smaller scale, individual plots, and buildings.

The third stage of Cihlar & Jansen's (2001) guide required a selective approach, to choose additional content for the resulting data visualisation. As Robinson, *et al.* (1995:10) explains, maps are representational tools for visualising relationships between two 'elements of reality', these being location and attributes, and any additional content must support the map's purpose, to hold and communicate geographical information in some form of spatial format. Adding further context to maps can hinder and divert the user's attention away from the map's intended purpose, masking key information by providing too much detail for purpose. However, further content can also be helpful especially with maps representing areas of rapid development and change. The features themselves need to be most accurate to provide a reference point for temporal comparisons and support the emerging patterns/trends/features (Kirk, 2016). Subsequently, the overall design process for the representations in this thesis were not straight forward, nor limited to just categorical representations of data. Robinson

(1952:8) describes maps as a ‘complex stimulus’ whereby the tool itself can prevent the user from creating conclusions based on initial impressions and a first glance look. Instead, they are purposely designed so that the individual must use a key or legend to access the information, to begin formulating their own perceived story from the data visualisation. This leads to the next focal point of discussion, the designing of an effective land use classification key.

A Contested Key

Visualising land use requires a system of colour associations to distinguish the various types of land function and corresponding purpose and I was not expecting to find a pre-defined, professionally used colour classification scheme that would suit my research needs. My research did not find any examples of either a UK-based land use classification scheme or a pre-determined set of classes that were suitable for the specifications of this research. As a result, I approached various literatures and pre-existing examples to construct an effective land use classification key to design one suitable for the audit maps presented later. The research drew upon the works of four specific sources to create the colour classifications outlined in Table 2 below. These were:

- 1) Jeer & Bain (1997) ‘Traditional Color Coding for Land Uses’
- 2) American Planning Association (2001) ‘Land-Based Classification Standards’
- 3) Brabyn (1996) ‘Landscape classification using GIS and national digital databases’
- 4) Zhou, *et al.* (2014) ‘Quantifying Spatial Heterogeneity in Urban Landscapes: Integrating Visual Interpretation and Object-Based Classification’.

Colour	Land Use Category	Example
	Residential- Singular	Single-family and town houses
	Residential- Multiple	Multi-family and high-rise
	Commercial	Including retail
	Industrial Uses	Offices
	Institutional & Public	Facilities- schools and health care
	Recreational	Uses- forests and reservations
	Industrial Utilities	Light uses

Table 2: Land Use Colour Classification

(Jeer & Bain 1997:1)

Though three of these sources are U.S. based pieces of research, this is not to be deemed a limitation. Jeer & Bain (1997) and the American Planning Association (2001) have facilitated the construction of the key by providing examples of pre-existing land use and classification criteria, and an indication of the most used colour references for major land use categories.

The next step was to determine the classifications themselves, ensuring both suitability and replicability at each of the three research location sites. If a land use classification was not present at one of the research locations, it was not ignored nor removed. Instead, it was justifiable to not include it in the key for that specific location and prevent any false assumptions. To determine the land use classes I began interpreting pre-existing LC maps and various other forms of aerial imagery, acquiring additional authentication through site visits, photography, and of course fieldwork. It meant that there was a degree of flexibility in my approach to using the LU maps as over time, the area's function and purpose had the potential to change between each period of data collection. Once these classes were decided, choosing suitable colour allocations, and beginning the symbolisation process was the next step. Observing Figure 13 below, the land use classification key is split into two categories; 'land use' which refers to the main function of the land and 'landscape feature' referring primarily to land cover, though does include specific landscape components and characteristics (i.e., water systems and valleys). This was done to differentiate between LC and LU maps and provide the context to visualise different types of information, such as identified landmarks and monuments versus themes of landscape appreciation, landscape satisfaction, and so on.



Figure 13: Colour Classifications: Landscape & Land Use

Source: Author (Developed from Jeer & Bain 1997; American Planning Association, 2017; Brabyn, 1996; Zhou, et al. 2014).

Figure 13 does not have any complex levels of detail associated to the land use representation, so each classification has a unique corresponding colour and code. Had the LU map required additional detail from a finer scale, the next suggestion would be to associate different shades or 'hues' of colour (Monmonier, 1996), such as different shades of colour on a scale of orange to red representing commercial land uses (Jeer & Bain, 1997; American Planning Association 2001). In comparison to Table 2 on the other hand, there is no differentiation between the

types of residential and industrial classes, so these were altered to facilitate the research. In Figure 13, the brown land use was allocated to represent woodland instead of multiple residential uses, the purple land use was allocated to specific institutional and public spaces, such as places of worship, instead of industrial uses. However, by conducting the pilot tests and initial site observations, I found that there were classes missing and necessary to include, i.e., transportation zones, abandoned space, and education. Jeer & Bain (1997:4) provide an additional ‘summary of frequently used colours’, explaining that areas of more common land use types may be represented with colour, i.e., transportation is often associated to blacks and greys, and public and governmental lands are often pink. However, for classifications that do require different hues of colour, it is important to remember the design specification and intended purpose of the map. Allocating colour hues to different unnecessary levels of detail could risk confusion with other types of cartographic representation that do rely on hue to reflect intensity (Monmonier, 1996).

Referring to the ‘landscape features’ noted in Figure 13, these were based on interpretations of land cover from various types of aerial imagery and are supported by site visits and fieldwork observations. To associate the colour symbolisations for each of the feature classes, supported by Zhou, *et al.* (2014), Brabyn (1996:279) suggests that various landscape features and characteristics come under two different groupings, ‘attributes’ which refer to landform, water and vegetation, and ‘components’ which refers to objects that make up these attributes (such as forests and lakes). For this research, the classification key focused on the ‘components’ part to provide indications of areas that may contribute and influence the responses and behaviours of individuals in cultural heritage landscapes. These included large bodies of water (oceans and lakes), smaller bodies of water (ponds), water systems (rivers and canals), open spaces (fields and moors), and man-made areas (golf courses). These could support the analytical process to investigate landscape perception and contribute any evidence that may support/challenge identified geographical themes (i.e., attachment to place).

Colour symbology was difficult because finer details were required from the key to accurately represent specific landscape features. For example, to differentiate between ‘valleys/floodplains’ and ‘wide open space’, it was necessary to pinpoint different shades of green, so that I could recognise the difference between the two. Another example referred to the colour allocation for ‘water’, which is commonly represented by the colour blue. However, Figure 13 shows three different classification categories that could be aggregated under water features; large body of water, small body of water, and water systems (Zhou, *et*

al. 2014; Jeer, *et al.* 1997; American Planning Association, 2001). In this case, the classes were defined by the following in Table 3:

Colour	Land Use Category	Example
	Large Body of Water	Oceans & Lakes
	Small Body of Water	Ponds and Minor Streams
	Water System	Rivers & Canals

Table 3: Landscape Feature Symbology

Source: Author

(Developed from Zhou, *et al.* 2014; Jeer, *et al.* 1997; American Planning Association, 2001)

Observing Table 3, this integration of visual interpretation is necessary to ensure accuracy and strengthen the effectiveness of the classification system, such as taking the observations of the human eye and using GIS tools to interpret the land cover (Zhou, *et al.* 2014; Brabyn, 1996). However, there was a risk that these classifications could still overlap, as landscapes cannot be simply divided and categorised into groups (Brabyn 1996). The boundaries between various land uses and land covers are also key physiognomies of landscape because these areas are often more susceptible to activity and interaction with people (Brabyn, 1996), such as road networks and pathways. Though Table 3 does not include any examples of these types of boundary other than the water system classification under ‘landscape features’, it was possible to add pathways and road networks as a data layer and provide the visual context for these types of boundary where necessary. Again, GIS was a useful tool regarding its capability to layer information for visual interpretation, but also in developing the land use classifications themselves (Brabyn, 1996).

Monmonier (1996:163) quite rightly describes colour as a ‘cartographic quagmire’. Whilst colour can make maps look striking and provide effective representations of information, it is

still a very complex and difficult tool to get right. Without any background research or acquiring even a basic understanding of how to apply colour appropriately, a level of ignorance can be harmful to both the map and the user. On the other hand, Yau (2011) suggests that the data visualisation process does not come with a specific set of rules or a methodology to follow and this has been the case when allocating colour to land use classifications. It means that there is a required level of flexibility associated with the construction of the land use key, to make sure that any necessary changes still meet the needs of both the data and the data representation. Moreover, I wish to reiterate that whilst Figure 13 was used to create and develop an initial draft of the land use classifications, these classes are dependant of the design specification associated to this research project. The classifications themselves required additional proofing through the construction of the LU maps in GIS, to ensure a level of clarity and replicability, and function as a representative tool for data communication.

The chapter will now turn to audit surveys and critique their role as a quantifiable data collection tool, engaging with Ewing & Handy's (2009) key conceptual framework to understand how the environment can persuade people's perception and experiences, providing the context to develop an audit survey capable of recording this detail and description. By developing the method in such ways, the audit surveys contribute a new rubric for measuring responses to environments across rural to urban settings (Harvey & Aultman-Hall, 2016). Using mapping techniques, the collated data is then selectively presented in three different audit maps to serve as supplementary representations.

4.4 Audit Surveys and Cartography

Audit surveys are a tool designed to collect observations of specific landscapes, based upon pre-determined themes, concepts and principles (Southworth, 2003; Harvey & Aultman-Hall, 2016). Information may consist of observations relating to people's actions and behaviours within a variety of locations and be used to investigate how people interact within specific environments and settings (Brownson, *et al.* 2003). For this research investigation, I developed my own audit survey⁵⁷ to collect and quantify information corresponding to eight specified themes/concepts (see Appendix A), covering a range of topics to direct my observations, such as the weather, environmental characteristics, facilities, and aesthetics.

⁵⁷ See Chapter 3.0, section 3.3.2 Audit Surveys

Unlike questionnaires and participant observations, audit surveys are reliant on scale to determine and define both the environments required for the investigation and the themes for observation. Discussed further in the following section⁵⁸, this investigation developed audit surveys that focused on information collated at the microscale, whereby elements that could directly affect people's experiences of place were recorded alongside corresponding social responses and behaviours (Sallis, *et al.* 2011; Cain, *et al.* 2014). These included design features in an environment, the quality of services and surrounding aesthetics which may persuade a certain perception or response. Using a series of closed questions, I recorded detail and description regarding peoples' attitudes and behaviours and quantified the results to facilitate the creation of cartographic data representations. Any further details that I felt were necessary to record from the audit survey observations were recorded using open-ended questions and formats, such as comment boxes.

4.4.1 Perception, Place and Persuasion

Beginning with Harvey and Aultman-Hall (2016), their work offers a review about a series of descriptive, exploratory approaches for measuring the physical environment, specifically, the social processes and activities that occur in response to specific landscapes and surroundings. Looking at 'streetscapes', their focus was how the built environment can affect liveability, observing factors including social interactions within the community, aspects of place identity and how individuals' travelled within each area of interest (Harvey & Aultman-Hall, 2016). The environments chosen as part of the research investigation were defined as 'livable streets' and encouraged residents to commune and interact with one another, subsequently associating place identity to the areas in which they live (Appleyard, *et al.* 1981, cited by Harvey & Aultman-Hall, 2016:153). Harvey and Aultman-Hall (2016) attempted to measure experiences through extensive interviewing with people within San Francisco (the study location), however found that whilst a liveable street was too broad a term to use, their study needed to incorporate an understanding of the conditions that supported the residents' livelihood. More specifically, the collated qualitative information provided a subjective understanding of people's interactions and perceptions, however further objective observations were required to either support or disprove their findings.

Whilst interviews are an invaluable data collection tool for acquiring qualitative detail and meaning, (Punch, 2005; Valentine, 2005; Bryman, 2016) investigating people's aesthetic

⁵⁸ See Harvey & Aultman-Hall (2016).

responses to landscape requires taking note of the physical factors and features that may have persuaded individual's ideas and opinions. Explicitly, the behaviours and responses that were recorded by the audit surveys stemmed from an understanding of landscape as an amalgamation of perception and the formulation of perspective (Duncan and Duncan, 1988; Cosgroves and Daniels, 1988). Being the representation, the visual and the veil, Wylie's (2007) conceptualisation⁵⁹ means that the perceptions recorded within each identified setting related directly to landscape as an object, seeing landscape as both an image and a text to present symbolic associations (Sallis, *et al.* 2011; Harvey & Aultman-Hall, 2016). Ewing & Handy (2009:67) consider these perceptions as an awareness of a person's surroundings, with the role of perception being to 'intervene (or mediate) between physical features' and provide a range of humanistic behaviours or responses.

Cultural heritage landscapes are more susceptible to this process⁶⁰ due to the range of architectures, features and buildings that characterise these areas. Specifically, individuals subconsciously look for points of reference to associate various feelings, meanings, and beliefs, finding their own sources of representation within identified places (Wylie, 2007, Vecco, 2010). By identifying and observing reactions to various symbols and icons present within each research location, it was possible to understand the application of value to cultural heritage landscapes. Using the five identified sense of place components⁶¹, I was able to guide my observations and tailor the data collection agenda specifically to search for evidence of each. Variables such as urban design, architecture, street characteristics and the weather, were also essential to record as they too could influence the relationships between people and place. Subsequently, there is evidence to suggest that physical features can influence the opinions and ideas of individuals within specific environments; the audit survey was therefore an ideal method for collecting this information.

To transform this information into forms of data visualisation, a categorical, quantifiable approach is required to ensure I can facilitate the data representation process, by turning the description and detail into formats that the GIS software can manage and process. However, collating information about social interactions and perceptions is a complex matter. The audit survey needed to measure humanistic concepts and themes at the microscale, collating observations associated to urban design and how these may have influenced the perceptions

⁵⁹ See Chapter 2.0, section 2.4 Experiencing Heritage Landscape

⁶⁰ See Chapter 2.0, section 2.4.1 Visual Space and Human Observation

⁶¹ See Chapter 2.0, section 2.4.2 The Landscape Veil

and opinions of the community. More specifically, the audit surveys had to be suitable for collecting detail and description in relatively small areas across each of the research locations, seen in the previous the allocated DCPs⁶². The survey was designed with specific questions where responses could be aggregated into more generalised findings if necessary, covering a broader range of topics suited to the research design; for example, street characteristics, land use, aesthetics, and indicators of a social environment (see Appendix A). To investigate sense of place would require understanding the ‘quality of human-environment association’, to measure categories within environments deemed more meaningful and unique (Harvey & Aultman-Hall, 2016:153).

Shamai (1991, cited in Harvey & Aultman-Hall, 2016:153) did just this by developing a rank system for sense of place, based on Relph (1976) and the seven modes of insideness and outsideness, to survey students and ‘their place connectedness’ across various geographical scales. These types of investigation not only allow for the survey of specific concepts, but by using larger spaces to test their implementations, it was possible to observe the effects from physical characteristics, like the buildings and tree-lined streets (Harvey & Aultman-Hall, 2016). Additionally, there is another example by Guo & Loo (2013) in New York and Hong Kong, where participants were asked to identify various walking routes on maps and rate those areas using Likert Scales. They were looking for indications of how the built environment may persuade its inhabitants to act, i.e., walking, cycling and public transport use. Here, the responses were tested against physical attributes located along each of the routes identified, to see if the environment itself had any effect or persuasion on the choice of route. Their aim was to ‘quantify the perceived utility of the pedestrian environment as revealed by pedestrians’ actual behaviors’ and develop an understanding of the links between spatial environments and human behaviour (Guo & Loo, 2013:126). By using Likert Scales, it was possible to quantify the responses given by the participants to acquire descriptions of the data (i.e., the mode, mean and standard deviation), whilst transforming the vast quantitates of data and results into accessible forms, such as percentages of respondents and the average scores for each of the walking routes. This research design and approach to observing human behaviours within specific environments provided an incentive to consider a similar approach for this PhD thesis, specifically incorporating different types of question format to facilitate the collection of specific types of data and information.

⁶² See Chapter 3.0, section 3.5 A Collection Strategy.

One example of a pre-existing audit survey is the ‘The Rural Active Living Assessment’ (RALA) (Yousefian, *et al.* 2010). This was devised in response to research on measuring the activity-friendliness of rural communities however environmental qualities across each of their research locations differed and there is universally suitable tool available. To resolve this, they observed factors and themes that were consistent across the rural areas and drew inspiration from other urban-based examples, to pinpoint the elements needed to support their research (Yousefian, *et al.* 2010). In this research, the requirements for collecting measures of people’s responses to environments are going to vary depending on both the researcher’s needs and the type of study they are conducting. To address this issue and contribute a more suitable urban-rural audit survey design, this research takes on board the ideas of Yousefian, *et al.* (2010) and teams it with other existing audit surveys⁶³. Consequently, the audit surveys in Appendix A can record both physical features and attributes, and behavioural and perceptive responses to landscapes.

I will now discuss my approach to formulating an audit survey, developed with the combined insights of Brownson, *et al.* (2003), Day, *et al.* (2005) and Day, *et al.* (2006), and the conceptualised framework of perception offered by Ewing & Handy (2009). Lee & Talen (2014) and Brownson, *et al.* (2009) support the use of the ‘Irvine-Minnesota Inventory’ by Day, *et al.* (2005), deeming it a well-known example of how to observe space and measure individual’s’ behaviours and perceptions. The corresponding guidelines provide a clear indication of the process/strategy for use (Day, *et al.* 2006). I will then present three ‘audit maps’ designed to present selected categories of data collated from the survey and discuss their use as supplementary representations for exploring the complex relationships between and place.

4.4.2 Environmental Audit Maps

To develop an audit survey for this research investigation, I observed three pieces of work; two provided by Brownson, *et al.* (2003), these being an *Analytic Audit Tool* and a *Checklist Audit Tool*, and a third by Day, *et al.* (2005) titled the *Irvine Minnesota Inventory* alongside its guidelines for use (Day, *et al.* 2006). Each example survey is constructed with a range of question types, with a purpose to collect information in quantifiable manners for data processing. Observing Appendix A, I incorporated closed-ended questions such as rank systems and Likert Scales, tick-boxes, and multiple-choice answers, to quantify individuals’

⁶³ See Brownson, *et al.* (2009), Day, *et al.* (2006) and Day, *et al.* (2005).

perceptions and begin formulating the links between people and place (Brownson, *et al.* 2009; Guo & Loo, 2013; Harvey & Aultman-Hall, 2016). Open-ended questions were used to provide further detail and reasoning regarding the user's responses and choices. These questions were structured into a sequential order and grouped into relevant categories before the pilot testing commenced, followed by data collection at each research location (see Appendix A). The audit surveys were completed at each designated DCP and upon completion, the data was processed manually into Excel. This occurred after each temporal phase. The categories include:

- Weather- a series of tick-boxes whereby all relevant conditions could be selected
- Area Identification- to consider whether each collection point had some form of sign or notice that indicated the entry or name of an area
- Street Characteristics- such as the size of the street and any distinguishing features, like lighting and crossings
- Pathway Characteristics- such as the size of the path, its perceived purpose, materials, and available amenities (i.e., bins)
- Land Use- like land use mapping previously, the information here was based on observations rather than secondary sources, i.e., aerial imagery and photography
- Facilities- such as car parking, abandoned buildings or plots, public toilets, and bins
- Aesthetics- relating to the maintenance of the area, such as litter, broken glass, the visual outlook of the area and perceived level of attraction
- Social Environment- identifying who was present in the area (children, teens, adults, elderly), and their perceived behaviours

To turn the audit data into a form of data visualisation, I focused on the results from Durham City, seeing as the research location was much smaller and more concentrated than Esh Winning and Stanhope. I looked over the collected datasets and filtered through the usability survey, working out which categories of data would be suitable for turning into data representations. I chose 'Land Use Environments' with corresponding questions 7 and 8 as these related directly to the creation of a land use map, 'Aesthetics (Sensory Attributes)' with question 19 as this asked for perceptions on visual outlook and atmosphere, and finally the 'Social Environment' category with questions 20, 21, and 22, as these enquired about social activities and the perceived demographic observed within each location. To discuss these in more detail, I will structure the remainder of this sub-section in relation to the identified categories and present each corresponding map alongside.

Land Use Environments

Observing Figure 14 below, I produced the land use map using a combination of the audit data, photographs, aerial imagery, and onsite observations to identify the predominant purpose of each building. Using ArcMap, I first imported basemap data from Edina Digimap to be able to trace the outlines of the buildings in the area. I cross-referenced this with aerial imagery to ensure there were no additions/demolitions that had taken place and the details were accurate. I then created a series of polygons under each associated land use and began to work my way around Durham peninsula. Once these were complete, I applied the landscape and land use colour classification I had previously devised and presented⁶⁴ to create a suitable symbology for the representation; commercial zones are red, residential are yellow, religious zones are purple, and so on.

Notably, there are also DCP buffers of 100m applied to the land use map which identify the line of sight from each DCP. In doing this, it is possible to describe the land use characteristics in and around each collection point and suggest potential justifications for actions and behaviours recorded at each DCP. For example, DCP1 is on the bridge in the south-west corner of the map where there appear to be open-views, natural landscape features and woodland. To those familiar with the area, users could determine that this spot may be used more by those travelling to/from Durham itself being one of the key walking routes into Durham, but also a location where individuals gather to take photos and look around their surroundings. They are helpful when wanting to conduct much smaller scale investigations by visually determining the extent of the observation, of where the audit was conducted.

On the other hand, there is some overlap between the buffers, especially where some locations are in closer proximity than others. The buffers around DCP4, 6, and 7 overlap which increases the risk for duplicate records to be recorded. However, upon closer inspection, DCP4 and 7 are less susceptible to this because each are set within a built environment. Though the map does not provide this detail, existing knowledge and experience from the pilot tests and data collection mean that I can use this context as additional detail when interpreting these maps. DCP6 and DCP7 however, are much closer together, but by using the visual parameters, it is possible to distinguish that each area is characterised by different land uses.

⁶⁴ See section 4.3.2 Designing a Classification and Symbolisation

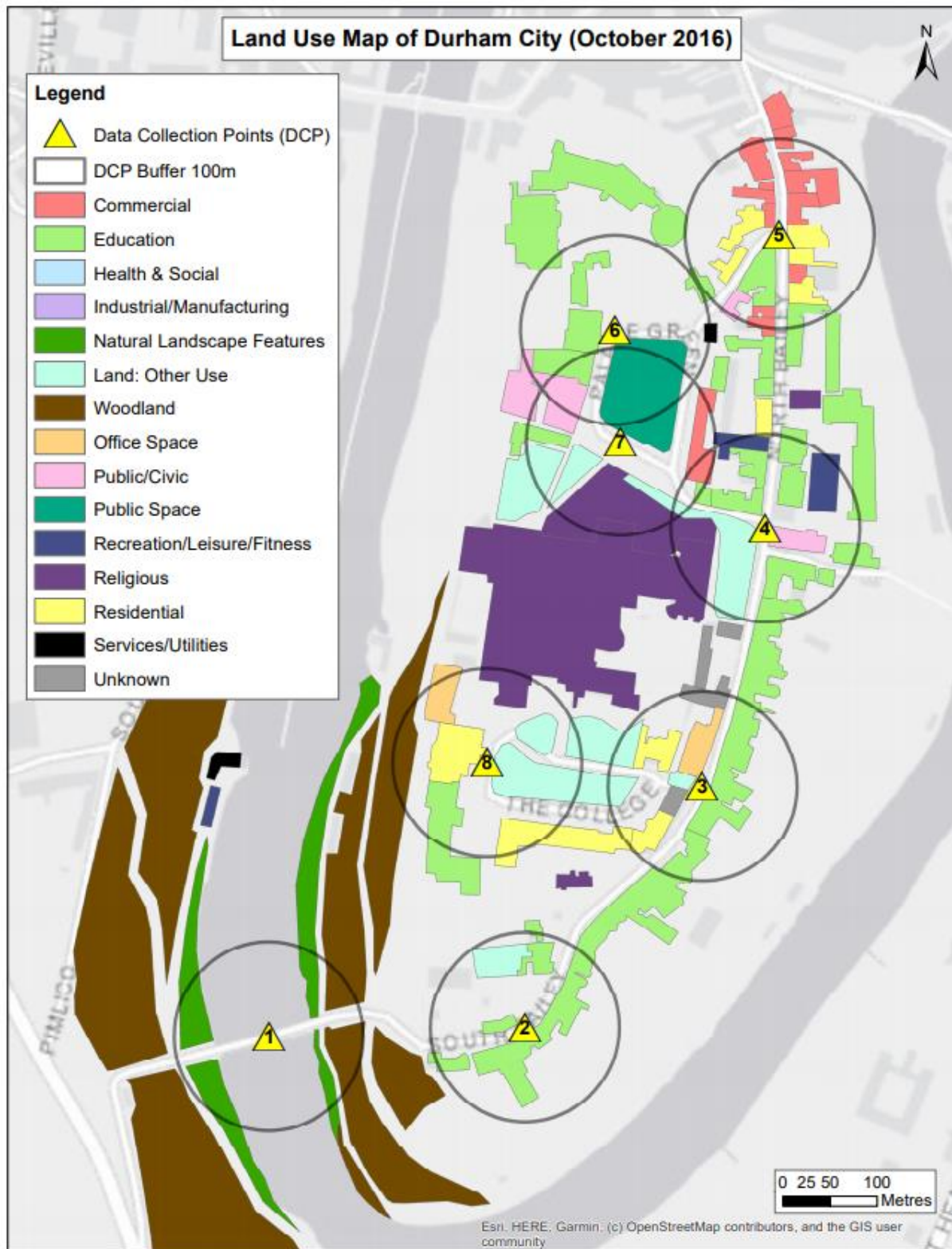


Figure 14: Land Use Map of Durham City (October 2016)

Aesthetics (Sensory Attributes)

Figure 15A below presented the data collected from question 19 of the audit survey, ‘Please rate a response to the following questions...’ Here, there are four rating criteria alongside Likert scales, which ask the user to indicate their level of positivity to the question provided question, these being 1 (not at all) to 5 (very). These include:

- a) How safe do you feel walking through this area?
- b) How historically significant do you think the area is?
- c) How picturesque do you think the town/city is?
- d) How ‘smelly/aromatic/pungent’ do you think the area is?

The results follow the rule that the higher the value, the stronger the positive response to the environment. The questions above were given a thematic name for representation, i.e., safety, Historical Significance, Picturesque and Negative Aromas, before the results were plotted into data graphics and applied to the cartographic representation. In this map specifically, radar charts are used to show the fluctuating responses around each of the DCPs and are set aside so that users can still observe the below basemap. This map uses a similar basemap to that of the previous land use map, with buildings already outlined and key labels applied. These add additional spatial context for users to associate with each DCP and acquire further context to decipher the results.

From the map below, the representation allows the user to observe the four themes relating to aesthetics and sensory attributes. All the DCPs are perceived to be safe and there are no negative aromas associated at all. Historical significance is prevalent, though is less evident at DCPs 1 and 2. This suggests that the areas around the centre of the map, being the main peninsula area, are seen to be of some historical value, whether due to the architecture and design, the variety of buildings, and/or other qualities which may define those spaces. Subsequently, this map enables to user to explore initial perceptions of landscape themes, prompting further enquiry and details to find out why.

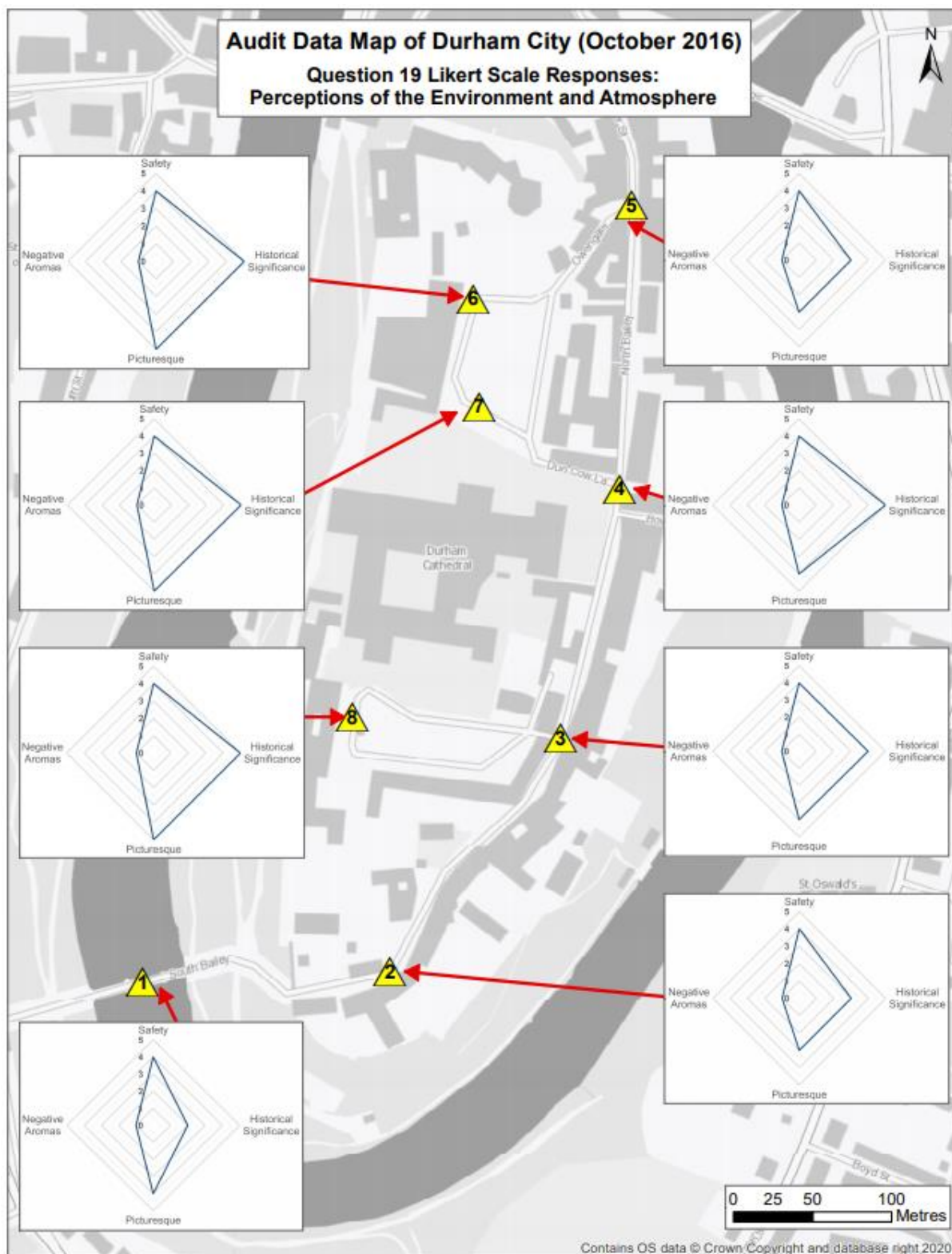


Figure 15A: Audit Map of Durham City: Perceptions of the Environment and Atmosphere (October 2016)

Social Environment

The third audit map focuses on the observed demographic, being the assumed ages of individuals seen at each DCP during the data collection process. Here, I did not collate this information from everyone observed, instead I estimated their ages based on visual interpretation alone. This may be open to discrepancy and accuracy, however the audit map does not need to collate demographic data for a specific empirical focus. The purpose of the representation is to communicate observations about environments and a representation of measures to explore individual's' behaviours and perceptions. If more specific details are needed, then this could be taken from the questionnaire data.

In this representation, the numerical values are not quantities of people but are counts of presence, being whether that specific age group was seen in that location. In this case, the total is four as this relates to the aggregation of the results for four key questions, in relation to the defined demographic. Specifically, question 22 of the audit survey distinguishes four questions relating to activity, and these asked about each age range:

Children ≤ 12 Years	a) Are there any children visible in this segment? b) Are there any children engaging in physical activities? (i.e., hiking etc.) c) Are there any children engaging in day-to-day activities? (i.e., shopping, dog walking) d) Are there any children engaging in visitors/tourist-based activities?
Teenagers or Adults 13-65 Years	e) Are there any teenagers or adults visible in this segment? f) Are there any teenagers or adults engaging in physical activities? (i.e., hiking, etc.) g) Are there any teenagers engaging in day-to-day activities? (i.e., shopping, dog walking) h) Are there any teenagers or adults engaging in visitors/tourist-based activities?
Older Adults ≥66 Years	i) Are there any older adults visible in this segment? j) Are there any older adults engaging in physical activities? (i.e., hiking etc.) k) Are there any older adults engaging in day-to-day activities? (i.e., shopping, dog walking) l) Are there any older adults engaging in visitors/tourist-based activities?

It is these questions which are aggregated to provide a score out of four, to determine which age brackets were seen at each DCP.

Further data graphics are used and applied to a basemap to create a cartographic representation capable of communicating audit data. Bar charts are used to visualise each demographic category observed at each DCP, showcasing evidence of the presence within the identified spaces. Like the radar charts previously, these are set aside from the DCP points so that users can still access the below basemap for spatial context. In this map, the areas around the centre of the map (DCPs 5, 6, 7 and 4) provide evidence that each observed demographic was present at each of those locations, but not in relation to all four activity questions. DCP8 is the quietest with only age 13-65 present. DCP1 showcases all ages of demographic however only age 13-65 were reportedly engaging in all areas of activity asked in the audit survey.

However, whilst this map does give an indication of the people within each identified space, it does not explain why. It may be able to describe the people observed within the area, but there is less in relation to who they were, why they were there, and what they were doing.

Additional information is needed from other sources, such as the questionnaire and interviews. Furthermore, this map cannot be used outside the context of this research as there is not enough detail presented to explain the 'measure of presence' nor address which areas of activity these figures relate to.

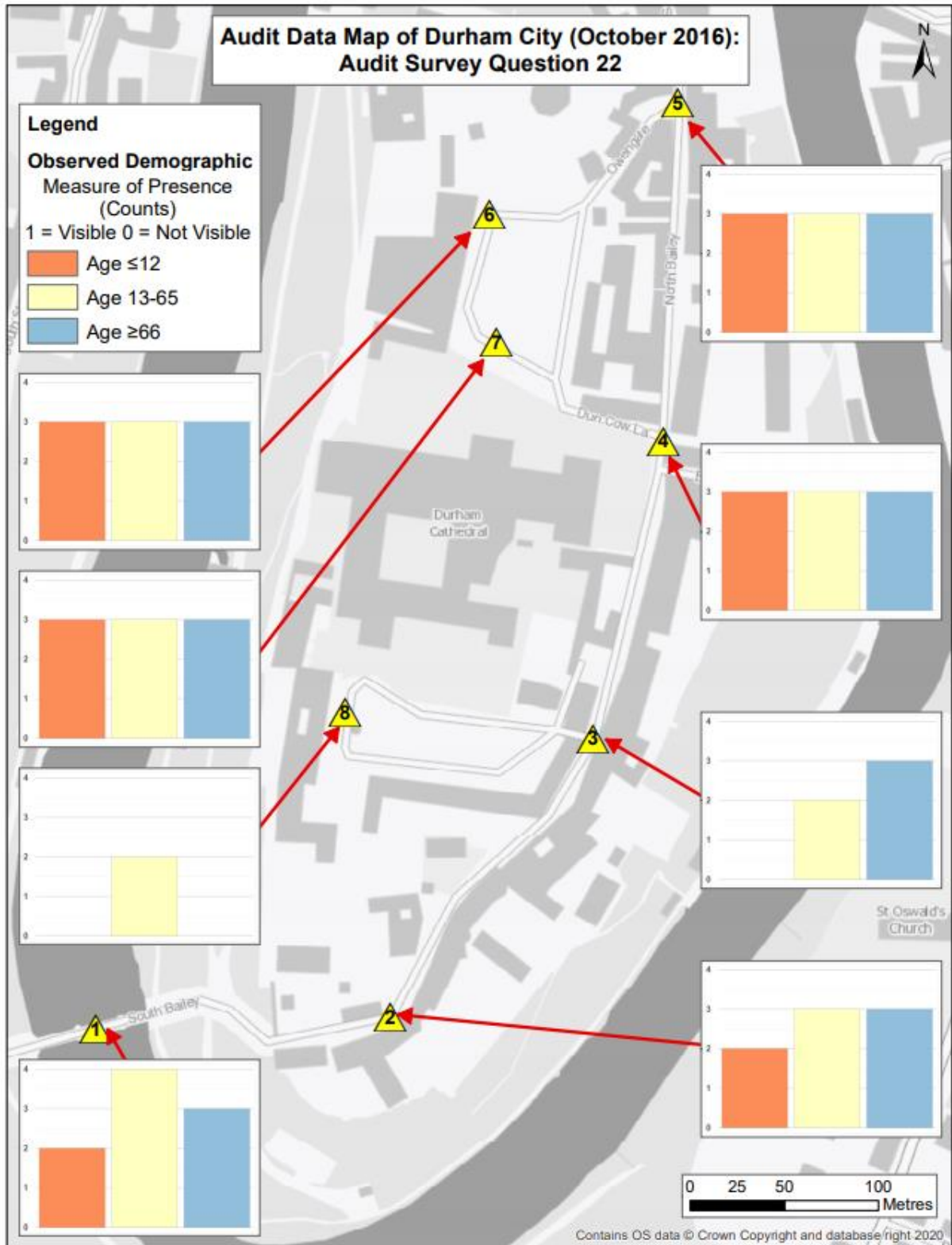


Figure 15B: Audit Map of Durham City: Observed Demographics (October 2016)

To summarise, the devising of an audit survey for this research has contributed a rubric capable of assessing rural to urban landscapes, recording categories of detail that can support an examination of landscape perception. As these maps are within the first drafts of their creation, further work is needed to make these more effective and consider any necessary constraints/limitations that the representations communicate. I would like to take these audit maps further and consider more creative methods for representing audit data.

In addition, quantitative focused techniques have assisted and contributed to the representation of qualitative information, whereby researchers need to engage with data management, processing, and manipulation procedures as part of an integrative recipe, to visualise perception and recorded behaviours geographically. The result has been the production of three audit maps which present categories of data about the perceived physical environment, offering further avenues for exploring how various spaces are used, who uses them, the atmosphere and experiences observed at cultural heritage sites, to uncover more about the complex relationships between people and place.

4.5 A Discussion

The aim of the chapter was to explore methods of collecting and presenting quantified qualitative data through categorical mapping and assess a technique capable of measuring landscape perception to facilitate cartographic data visualisation. These evaluations have facilitated an approach capable of integrating digital and non-digital, quantitative, and qualitative, to create a form of cartographic representation that can supplement understanding and enable the visualisation of landscape contexts, ranging perception to physical description.

Audit surveys have a key capability as a data collection tool to record observations from within specific, pre-determined environments about peoples' behaviours and responses to various landscapes (Brownson, *et al.* 2013; Day, *et al.* 2005; Day, *et al.* 2006). The audit in Appendix A is designed based upon the conceptual framework of perception and a tripartite understanding of landscape (Wylie, 2007; Ewing & Handy, 2009), that together observe how the physical environment can influence and persuade the perceptions of people. These perceptions are not simple ideas or constructs but are the result of various degrees of interaction from within complex social spaces, an overarching process that incorporates all sensory attributes and qualities (Mehta, 2008; Ewing & Handy, 2009; Britton, 2011).

Consequently, the audit survey produced evidence that this method can both record landscape perceptions and quantify qualitative detail suitable for data management and processing through computer software. By implementing a strategy to collate the data and associate the required spatial reference, the allocation of DCPs at each research site provide the spatial context to aggregate corresponding data to specific geographical references and facilitate a qualitative GIS. The audit surveys can function as an effective quantifiable tool enabling collated information to supplement other forms of data collection and resulting cartographic representations. As Guo & Loo (2013:127) suggest, there is no singular method or ‘assessment [that] can satisfy all needs’, so by using audit tools within a mixed method approach it is possible to use the qualitative detail from interviews and questionnaires, alongside that of the objective observations, to get a better idea of how landscape perceptions are created. Being able to compare different data types against one another will provide a better insight and a ‘more balanced picture of the phenomenon’ (Elliot & Timulak, 2005:151).

By considering perception as a conceptual framework, perception is not just the viewing and interpreting of information, it is a ‘process’ that incorporates all sensory capabilities (Ewing & Handy, 2009:67). It enables individuals to gather an in-depth awareness of their surrounding environment and generate their own ideas and knowledge, an incorporation of the physical attributes and more immaterial processes, like cultural factors, behaviours, and attitudes. Specifically, the categories identified have been allocated not only to enable the management and efficient collation of data but pinpointed because each one outlines some form of characteristic, feature or quality that may sway a person’s perception and attitude (Mehta, 2008; Ewing & Handy, 2009). For example, Ewing & Handy (2009), Mehta (2008) and Day, *et al.* (2006) suggest that urban qualities are a key consideration and goal in aspects of urban design. This could include evaluating access to local amenities that persuades use of local services and facilities, understanding the aesthetical appreciation of a specific place through architecture, surrounding views and land use, and/or investigating subjective reactions to place derived from perceptions of street characteristics, landmarks, and other personal associations (Ewing & Handy, 2009; Brownson, *et al.* 2003; Day, *et al.* 2006; Mehta, 2008). These categories may also show much simpler suggestions for behaviours, like better weather prompting more positive reactions to various landscapes and surroundings.

Parenteau, *et al.* (2008) are another example of where work has been carried out to investigate how the environment can impact a person’s health. In this study, Parenteau, *et al.* (2008) used a series of spatial indicators to collect data that may explain the relationship between

inequalities in neighbourhood quality and health disparities. The environment was considered key and encompassed the physical barriers that may influence and/or persuade the actions and behaviours of its inhabitants. They identified three domains of contextual indicators: goods, services and amenities, social environment and built environment, whereby each of these contained a series of indicators that would potentially explain the relationship between health and the environment. These included grocery stores, greenspace, accessibility to open space, crime, and housing type. In comparison to this research, the audit survey utilises a similar approach by categorising the data into themes of indicators that may explain the responses and interactions between people and the cultural heritage sites. The audit maps allow the users to compare the presented results with those from other datasets, drawing out further detail, potential patterns, and relationships. Subsequently, Parenteau, *et al.* (2018) found that amongst other factors, food outlets, access to greenspace and modes of travel all contributed towards the poor health of residents within their identified neighbourhoods. Being able to visualise this data enabled for exploratory spatial analysis, they considered both the social and environmental components that contributed towards poor health presenting the results in effective formats for an additional line of enquiry.

Regarding the creation of the audit maps, Serra-Coch, *et al.* (2018) suggest that these types of graphical expressions are a key tool for visualising the contextual spatial distribution and providing complimentary information for analysis. Visualising the data in such ways enables the user to spot patterns and trends within various environments, alongside the potential influences and characteristics which are not available in numerical value alone, such as the examples observed previously in Chapter 2⁶⁵, Snow and Minard were able to plot identified variables in ways that enabled a clear picture of their datasets and associated phenomena. Cartographic representations like the audit maps, can enable researchers to understand diverse layers of complex systems that may offer explanations for the interactions and behaviours seen in various landscapes and settings, in more effective, creative, and simpler ways. Additional context is needed to better understand the relationship between people and place, though these maps are a starting point for prompting and furthering geographical enquiries.

Appendix A is evidence that audit surveys are a useful tool if developed and implemented with the design specification at the forefront of the method across a variety of research ‘scapes’ (Pikora, *et al.* 2002; Lee, *et al.* 2005; Millington, *et al.* 2009; Yousefian, *et al.* 2009;

⁶⁵ See Chapter 2.0 sections 2.3.1 A Brief History of Mapping and Cartography and 2.3.2 Data Visualisation

Yousefian, *et al.* 2010). I have been able to contribute further by designing an audit suitable for a range of research settings and environments. Appendix A is the result of a tailor-made design derived from pre-existing examples, as there was no ready-made tool available. The audit had to be designed and adapted to fulfil my research needs, to capture humanistic responses to landscapes across three different research sites (Sallis, *et al.* 2011; Guo & Loo, 2013; Cain, *et al.* 2014). I emphasise that these methods (i.e., the use of LU and audit surveys) are an important means to quantify the qualitative regarding people's experiences of the landscapes. Though they are a more experimental dimension for devising such a methodology, they enable not only the data processing for analysis and representation, but also the initial sorting and categorising of raw data into relevant themes and categories prior to the collection process (Cihlar & Jansen, 2001; Southworth, 2003; Harvey & Aultman-Hall, 2016). It associates back to grounded visualisation as a key approach to engage with the underlying power of mapping to support this integration, making use of Cope & Elwood's (2009) qualitative GIS and the relevant iterative and recursive processes to explore my datasets (Crampton, 2013). Additionally, both quantitative and qualitative data types can be represented through a determined symbology. In this case, the power of mapping extends to the communication of interpretation through the spatialisation of both (Monmonier, 1996; Krygier & Wood, 2011; Crampton, 2013), using spatial methods to visualise and explore social phenomena in direct relation to surrounding environments and landscapes (Boschmann & Cubbon, 2014; Żyszkowska, 2016).

Chapter 5.0 Mapping Relationships, Patterns and Flows

5.1 Mapping Trends, Patterns, Correlations and Connections

As Yau (2011) has previously stated, there appears to be an absence of definitive guidelines for researchers to use to construct their own methods of visualising data. However, if researchers want to approach using visual methods and techniques, they should see it as a series of targets and strategies unique to their research. By having a critical appreciation of the research, it is possible to begin addressing more complex data sets and delve further to associate more detailed, descriptive data types.

The following section examines methods for presenting quantitative values about specific geographic phenomenon through spatial mapping dimensions, for example layering information on top of a backdrop map or through forms of distortion (i.e., shapes or the map itself) (Kirk, 2016). It focuses on Choropleth and Flow Maps regarding their ability to facilitate the presentation of qualitative data, where these visual representations differ to the previous section as they involve continuous values as opposed to nominal (categorical) data. The maps below aim to enable visual spatial analysis by interpreting patterns and distributions of phenomenon across predefined geographic scales. From the cultural heritage lens, their motive is to enable users to visualise and describe landscape perception themes in situ to spatial context, to tease out potential meanings and relationships between people and place. The use of colour symbology in each of the cartographic representations enable this by colour-coding quantitative values to specific colour ramps or classifications, taking categorical information and visualising it in accordance with spatial context.

I begin by examining choropleth mapping where researchers can present compilations of numerical data, like social statistics (i.e., gender and age), in cartographic forms. The data is aggregated to specific geographical scales and associated to similar colour symbolisation ideologies seen in LU mapping, to observe trends and correlations across various spatial scales. In doing so, the maps provide evidence that by quantifying qualitative data into distinct groups corresponding to specific geographical scales, it is possible to observe qualitative geographical patterns and trends in cartographic form.

5.2 Choropleth Mapping

The process of choropleth mapping involves aggregating attribute data to a specified geographic scale (e.g., local authority or postcode) and may refer to datasets compiled of

economic figures (i.e., income), demographics (i.e., household numbers, gender), manufacturing and labour (i.e., employment rates, gross domestic product), and many more (Punch, 2003:2-3). Choropleth maps visualise information by linking datasets to corresponding geographical areas and associating colour to provide a visual representation (Krygier & Wood, 2011; Yau, 2013).

The strategy to create choropleth maps is both replicable and suitable for developing qualitative cartographic representations. The following section will investigate their use as a form of data representation and the mapping of specific attributes by spatial category and colour classification. It will critique an example by Bimrah, *et al.* (2010) to highlight a series of issues and limitations regarding the data visualisation, and how these will facilitate considerations for designing research-related choropleth maps. This considers how best to apply key design attributes (i.e., value, legend, and boundaries) and the implications of their use (Krygier & Wood, 2011), acknowledging issues that choropleth maps are susceptible to (i.e., ecological fallacy, and modifiable areal unit problem) (O'Sullivan & Unwin, 2010; Bimrah, *et al.* 2010), and addressing further issues of scale, representation, and generalisation (Robinson, *et al.* 1995; Monmonier, 1996). The thesis will then present the resulting choropleth maps designed to showcase results from the October 2016 data collection, specifically identified postcode areas and corresponding visitor numbers.

5.3.1 Construction, Correlation and Colour Communication

Geographers are renowned for wanting to understand the links between human experience and various socio-spatial settings (Dwyer & Limb, 2001). This research investigation is no different. The generation of illustrations, graphs and maps provides new capabilities for researchers to visualise the relationships between people and place across a variety of scales, and with a variety of depth and detail. The analysis requires the provision of spatial context extracted through numerical representation (i.e., quantifying the qualitative), to present and interpret the resulting spatial trends and correlations (Sun, *et al.* 2015) and understand the characteristics and meanings associated to the data. The communication of the spatial patterns between represented variables is the main objective of any choropleth map design, including the ones I will be presenting within this chapter (Sun, *et al.* 2013).

Figure 16 below are representations of social statistics, mapping associated attributes by respected ward and assigning a colour classification key. The maps below present, a) the

population percentages classed as ‘minorities’ across Montreal, and b) the total average income by neighbourhood, within Montreal (Bimrah, *et al.* 2010).

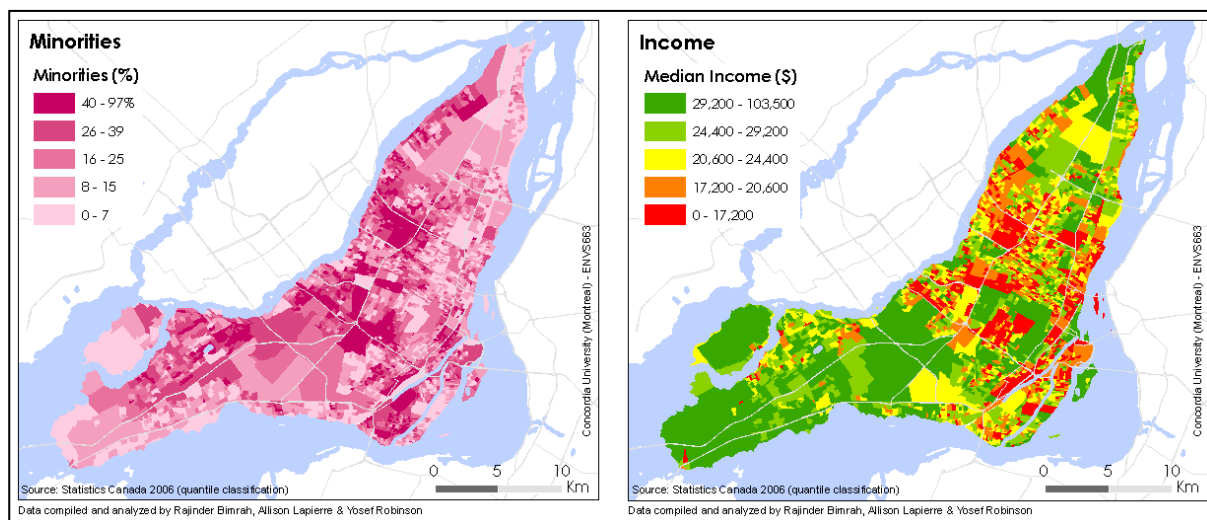


Figure 16: Minority Percentages & Median Average Income, Montreal
(Bimrah, *et al.* 2010)

Figure 16 allows users to visualise and compare the spatial distribution of both minorities and average income side-by-side, to decipher potential relationships and patterns between the two. More specifically, observing the south-west area of Montreal, the green shading suggests that neighbourhoods here have the highest average income; in correlation, the same areas on the minorities map tend to have lower percentages of people of a minority background. Observing the red patterns across the centre of the average income map, the lowest median income of 0-17,200 Canadian Dollars seemingly correlates to the dark pink shading on the minority percentage map, whereby these areas suggest having the highest percentages of populations from minority groups, i.e., 40-97%. A limitation, however, is that sociodemographic factors could include a variety of other factors, like age, gender, marital status, and so on. In the above example, the aggregated category is defined purely on the population’s identity as a minority and as a generalisation, it does not acknowledge finer details recorded a lower level. In this case, it can become difficult to ground⁶⁶ the data within the research, because a variety of data scales will have been merged to produce the cartographic representation.

However, a more detailed map is not necessarily any better. If the map were to zoom in on a more detailed level, it can become too complex to interpret because of the amount of data

⁶⁶ See Knigge & Cope (2006, 2009) and Elwood & Cope (2009) regarding ‘grounded visualisation’

being shown alongside cartographic clutter. To rectify this, it requires selectively choosing which areas are applicable to the research and compromising a loss of information and context about surrounding locations. On the other hand, I am unable to refer explicitly to the authors' methods and motives, as Figure 16 was created as part of a database using Statistics Canada 2006 (Bimrah, *et al.* 2010). However, the intention was to create two maps that presented information about two identified socioeconomic factors on the island of Montreal and enable a visual comparison by presenting each side-by-side. As these were collated by Statistics Canada, I can only suggest that the data collection process may have taken place on a much finer scale (i.e., by household), processed and aggregated to a bigger scale (i.e., by neighbourhood) to produce percentages regarding the proportion of minority populations in an area.

A more grounded approach would acknowledge the availability of scale, to see how these correlations and patterns vary across a variety of different levels (Cope & Elwood, 2009). For example, the minority percentages of Montreal appear to be calculated at city level and representative of several minority groups (Bimrah, *et al.* 2010), potentially an aggregated percentage for numerous ethnic groups such as Arab, Latin Americans, South Asians, and so on (Statistics Canada, 2017). If this detail were available in the original research by Bimrah, *et al.* (2010)⁶⁷, it would have been possible to find out more about the composition of minorities in Montreal and how these may correlate to the median average income of Montreal. In addition, a bivariate choropleth is also possible, created by combining both minority percentages and median average income into one visual representation (Stewart & Kennelly, 2010; Nusrat, *et al.* 2018). Here a matrix using clear, identifiable colour classes to facilitate the representation process with both variables assigned to a colour is needed; variable one being on the x-axis (minority percentage), and variable two on the y-axis (median average income). The bivariate representation can summarise data and simultaneously assess statistical and visual geographical patterns, whilst reducing the risk of errors through side-by-side comparisons (Nusrat, *et al.* 2018). However, a side-by-side comparison is more accessible and easier to interpret because there is less detail and clutter to distinguish from. Furthermore, conclusions made based on the visual interpretation of the two variables seen in Figure 16, do not suggest the findings are conclusive. They are still an interpretation of the data presented. It would require further testing through correlational tests

⁶⁷ Unfortunately, whilst the link in the bibliography provides details about the database used, the link itself does not contain a working URL to access the original dataset.

to see if there are any potential relationships between the two factors. This would lead the user to consider various hypotheses and investigate the phenomenon further.

There are two specific considerations to be cautious of. Firstly, choropleth maps are susceptible to modifiable areal unit problem (MAUP) where data that has been aggregated into small units is manipulated into larger, more generalized units (O'Sullivan & Unwin, 2010). Here, it is possible to lose detail associated to the data and hide potential correlations and trends. On one hand MAUP also associates issues referring to scale, whereby patterns might appear stronger/weaker within the data across different scales; a common example is a stronger relationship for data at a higher level. Another issue relates to the grouping of data at the same scale, such as the minority percentages and average median income at neighbourhood level. This regards how the neighbourhood boundaries are drawn in relation to both datasets, as the results can present different patterns if these are manipulated, altered, or changed in any way. Secondly, choropleth maps are susceptible to ecological fallacy, whereby researchers often assume relationships between variables based on a large spatial scale are the same at lower, more detailed scales (O'Sullivan & Unwin, 2010). For example, there may be a strong relationship between two variables at regional level, but this may not be the case if observed at county level. Scale may also be an issue with the presentation of findings and has similar complications as ecological fallacy. Whilst O'Sullivan & Unwin (2010) acknowledge that it is almost impossible to get the scale perfect for spatial analysis, due care and attention is essential. Nevertheless, there are still issues residing with these types of cartographic representation, as not all limitations can be addressed nor accounted for. They do, however, provide an example of how to use spatial analysis effectively, by manipulating the aggregated data through various software processes, to produce the resulting diagrams, illustrations, graphs, and maps.

Krygier & Wood (2011) consider three key attributes for creating effective choropleth maps, regarding the colour categorisation and ability to communicate information to its full potential. These attributes are 'value, legend, and boundaries' whereby the combining of these factors ultimately persuades the effectiveness of the choropleth map design (Krygier & Wood, 2011:189). Krygier & Wood (2011) use 'Wisconsin Farm Density' data to show the concentrations of farms every two thousand square miles. Using Figures 17A 'value and legend', 17B 'value and boundaries', and 17C 'value and legend and boundaries', each illustrates how important these attributes are and when combined, can facilitate an effective example of data visualisation.

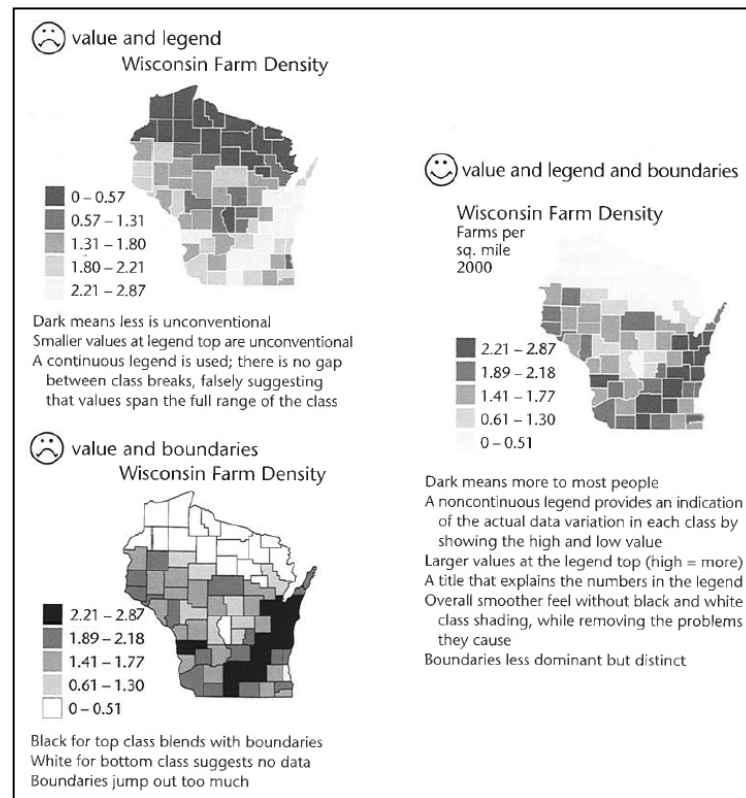


Figure 17: Important Considerations for Choropleth Map Design

‘Choropleth Map Design: Value, Legend, and Boundaries’ (Krygier & Wood, 2011:189)

- Figure 17A- Value & Legend

The trends and patterns presented are dependent on both the scale of the map and the number of data series/class breaks chosen to categorise the data. A key that outlines percentages in categories of 10% (i.e., 0-10%, 11-20%, and so on) would present different results to a key that presented percentages in categories of 25% (i.e., 0-25%, 26-50%, and so on). There are also conflicts in the map legend to address. First, by listing all the value breaks users would assume that the classes are representative of the data range, and wrongly so if the lowest value were 1.5 not 0. Secondly, in Figure 17 the values listed in the legend are ordered with the smallest class break at the top and allocated the darkest colour ramp, suggesting these to be the most important values to perceive. By associating the darker colours to smaller numbers, it suggests greater meaning and depth to these values and the corresponding spatial area on the map. The colours used should clearly distinguish each of the class breaks, or else be at risk of failing to support clear communication of results (Sun, *et al.* 2013).

- Figure 17B- Value & Boundaries

Figure 17B on the other hand, swaps the order of classes around, presenting the highest value breaks at the top of the legend with the darker colours to these values (Krygier & Wood, 2011:189). This is more effective however, using bright and bold colours can be problematic. Using white to represent the lowest values suggests there is neither no data nor any level of importance to the information regarding these spatial areas, hence no colour association. Additionally, using black as the darkest colour symbolisation to represent the higher values can cause the spatial areas to blend in with the area boundaries and causes issues of distortion, such as the perceived sizes of each area being larger than they are geographically defined (Krygier & Wood, 2011:189). Bimrah, *et al.* (2010) associates a green to red colour scale which may imply some initial correspondence to either temperature/heat, or levels of positivity/negativity. In this case, the lowest median income classes represented in red may imply a level of negativity, with the green representing more positive associations to having more money. Though an assumption, implicating these ideologies through colour symbology can persuade the users to think either more positively/negatively towards the presentation of income levels and the minority percentages. Having certain classes stand out can promote a strong visual interpretation, with the results at risk of being blurred together, miscommunicated, and subsequently misinterpreted by the user (Sun, *et al.* 2013).

- Figure 17C- Value & Legend & Boundaries

Figure 17C is the result of all three attributes being considered and applied more effectively to the choropleth map design. Here, darker colours still correspond to higher value class breaks, as it is easier for individuals to associate meaning and interpret quantity. This colour ramp and use of shading provides a better indication of data variation and removes any conflicting issues, such as misinformation provided by the white colour symbolisation in Figure 17A, and the distortion of boundary lines caused by the colour black from Figure 17B. Furthermore, this example also provides the user with a title to indicate purpose, alongside the provision of data units (farms per square mile). It provides clearer context for data interpretation, such as how large each area is and what the data values mean (Krygier & Wood, 2011:189). Additionally, the class breaks are symbolised clearly with a grey colour ramp (via different shades of grey), neither suggesting the strong indication of individual class breaks, nor the blurring of shades between each data class representation (Sun, *et al.* 2013).

Scale is also an issue where smaller scale maps can eliminate details seen on more detailed, larger scaled examples (Monmonier, 1996). Scales can also overgeneralise datasets though

these issues may be combatted with a more selective approach to the data representation (Monmonier, 1996). This requires researchers to be more precise when choosing data for representation, to prevent overcrowding on the finalised data visualisation. It ensures a level of transparency between the researcher and user, as well as providing a more accurate representation of the observed conclusions. Monmonier (1996) observes the process of map generalisation as a way of deciding what information should be presented, being a method for allocating icons to symbolise data sets. To do so successfully, cartographers must engage with two essential elements of content generalisation; 'selection and classification' (Monmonier, 1996:35). Selection refers to the suppressing of various elements of information to perceive those that are required for the map content (Monmonier, 1996). It requires at choosing specific features which have a capability to inform an audience using recognisable symbols, such as contour lines (Ordnance Survey, 2017). This is the classification element, whereby many features may be represented by one singular icon, however there is a further risk of generalisation when one symbol is used to represent more than one identified feature or point.

To conclude Monmonier (1996:35) remarks, 'function dictates form' and does not imply that the product must be as accurate or as correct as possible. Cartographers should selectively choose the necessary and required datasets rather than included a complete database. Users can map specific variables (i.e., gender, income, employment percentages) at certain scales and visualise the findings through categorical colour symbolisation (Krygier & Wood, 2011; Yau, 2013). Researchers must be clear about the main objective of their choropleth map, the required data and use scales that neither exemplify nor over generalize the representation (Robinson, 1995; Sun, *et al.* 2013; Sun, *et al.* 2015). Choropleth maps need additional verification and justification regarding the visual interpretations of variables, as they can fail to present data and their meanings when the design process has not been thoroughly adapted, trialled, and tested. The potential relationships observed can show a degree of strength in their correlation, but not be representative of the overall findings (O'Sullivan & Unwin, 2010). Additionally, this could be due to the data values and their resulting aggregation, the construction of the legend, and/or colour symbology allocation (Monmonier, 1996; Krygier & Wood, 2011; Sun, *et al.* 2013). When considering the development of more qualitative forms of cartography, it is essential to make sure that the resulting visualisations do perform effectively and communicate valid representations of knowledge.

5.3.2 Choropleth Creations

Incorporating Bimrah, *et al.* (2010), Krygier & Wood (2011) and Monmonier (1996), I approached the construction of three choropleth maps, representing information corresponding to either of the three unique research sites. From a methodological perspective, this involved implementing the collection strategy⁶⁸, to collect data that could be represented by colour symbology and presented cartographically. However, I did not need to be as strict with the DCP allocations regarding spatial references. The choropleth maps were created by aggregating data into postcode area groups; the postcodes having been provided by willing participants in the questionnaire. This aggregation enabled me to visualise the quantities of people from identified postcode areas and observe the spatial patterns through overlays and colour symbolisation. I had to source further secondary data from Edina Digimap (2018), who provided me with postcode data from OS OpenData. The data consisted of a series of shapefiles, each showing the outline of a postcode area by either area, district, or sector. The figures presented below use the district postcode shapefiles, created by OS in January 2015. Though dated, these were the most recent and available sources postcode data that I had access to, thankfully due to the university's subscription to Edina Digimap (2018).

Once this information was downloaded, each individual file had a unique corresponding attribute table that contained all the necessary details about each piece of data. These attribute tables can be manipulated, and additional information added to them for further interrogation (see Figure 18, violet box). The choropleth maps in this research required me to design choropleth maps that showed quantity, so additional fields were added to the attribute tables to note the corresponding postcode area, and how many participants provided the response (see Figure 18, orange and navy boxes). Once processed and placed into an ArcMap document, I manipulated the symbology to show the distribution of postcode areas, provided by willing participants at each of the research sites (see Figure 19, yellow box). Specifically, I used the HSV values to pinpoint a clear colour ramp, making sure each class was distinguishable for visual interpretation (Junhua & Jing, 2012) (see Figure 18, light blue box). I added a zero value so that the surrounding unidentified postcode areas could also symbolised and used for spatial context, rather than leaving them white and merge into the background (see Figure 19, pale pink box). The following maps use the records collected in the first data collection phase, October 2016.

⁶⁸ See Chapter 3.0, section 3.5 A Collection Strategy

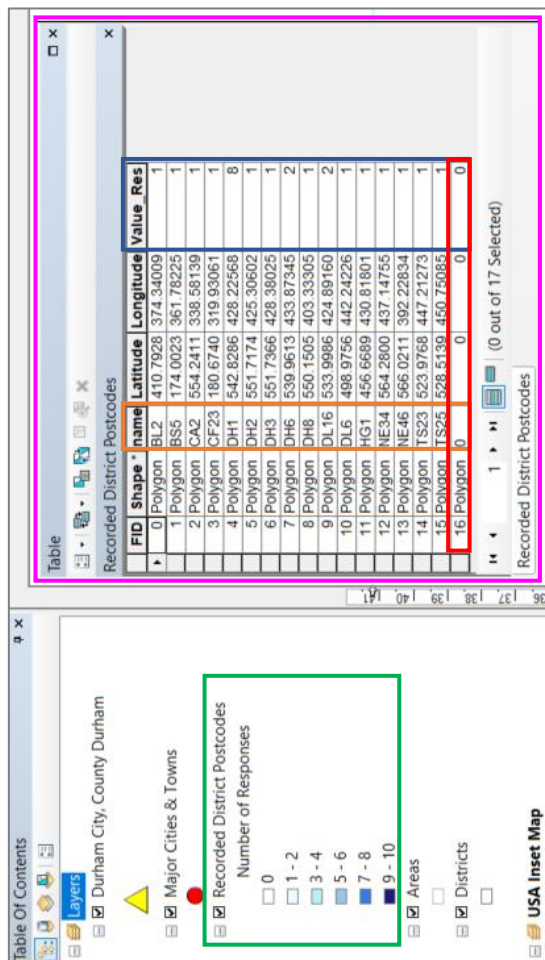


Figure 18: Attribute Table for the Durham Choropleth Map

- Key**
- Data File
 - Attribute Table
 - Postcode Areas
 - Number of Responses
 - Unidentified Postcode Areas (Zero Value)

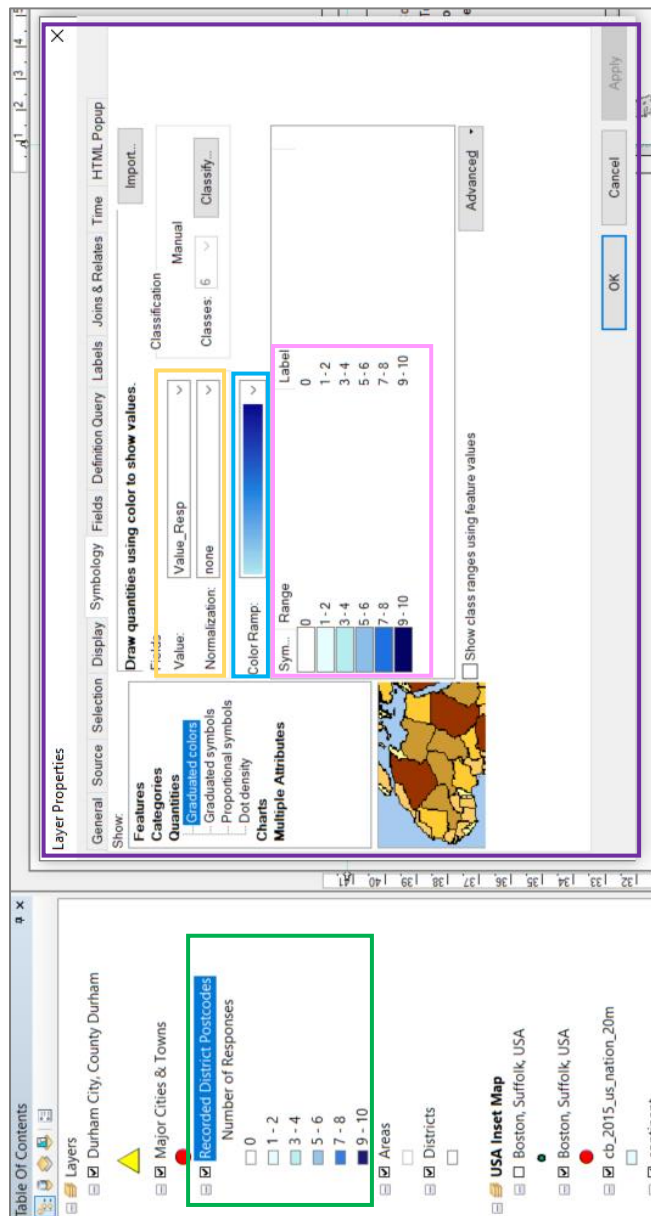


Figure 19: Layer Properties and Symbology for the Durham Choropleth Map

- Key**
- Data File
 - Layer Properties
 - Symbolised Values
 - Colour Ramp
 - Classifications

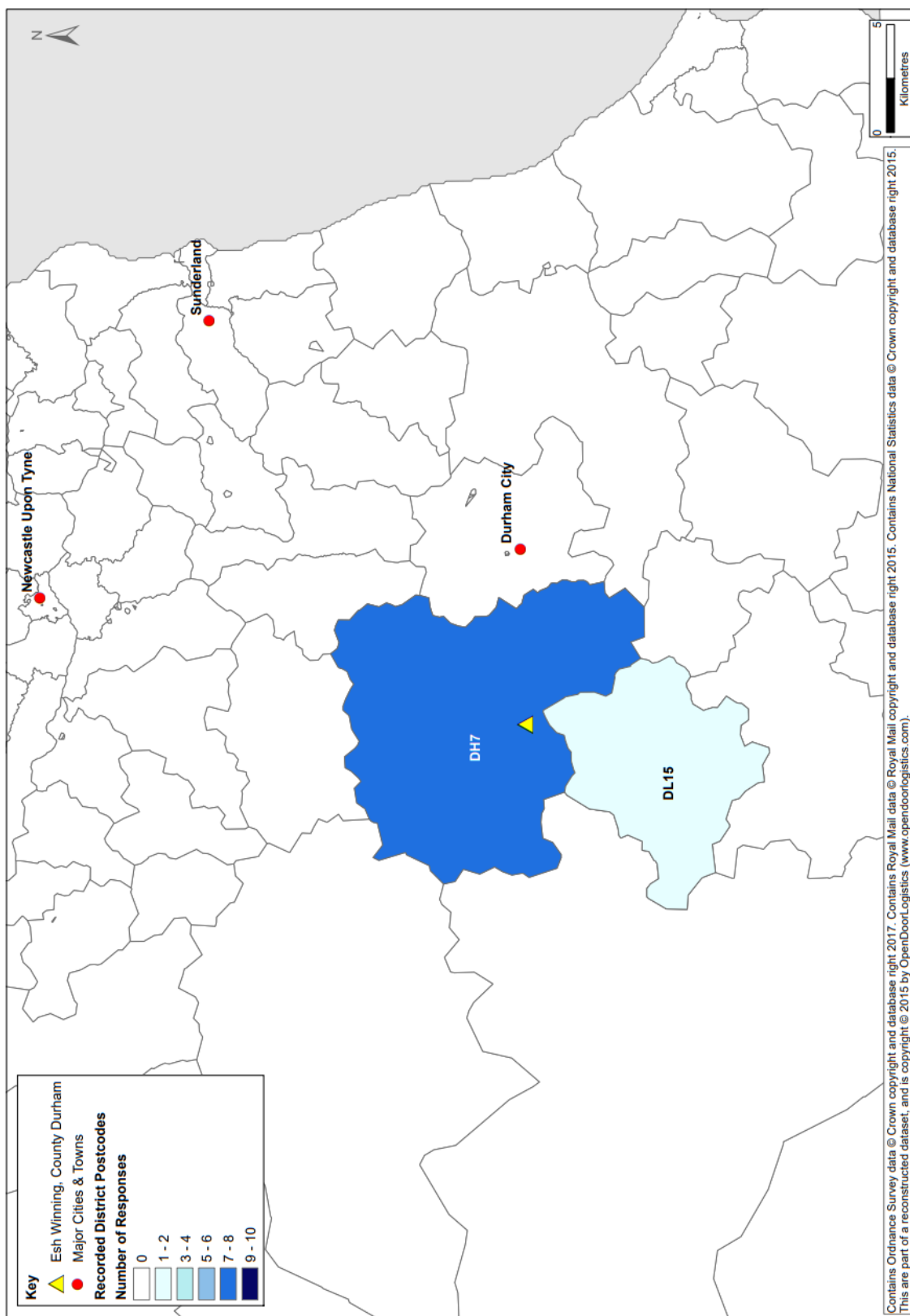


Figure 20A: Choropleth Mapping; Esh Winning & the Deerness Valley Railway (October 2016)

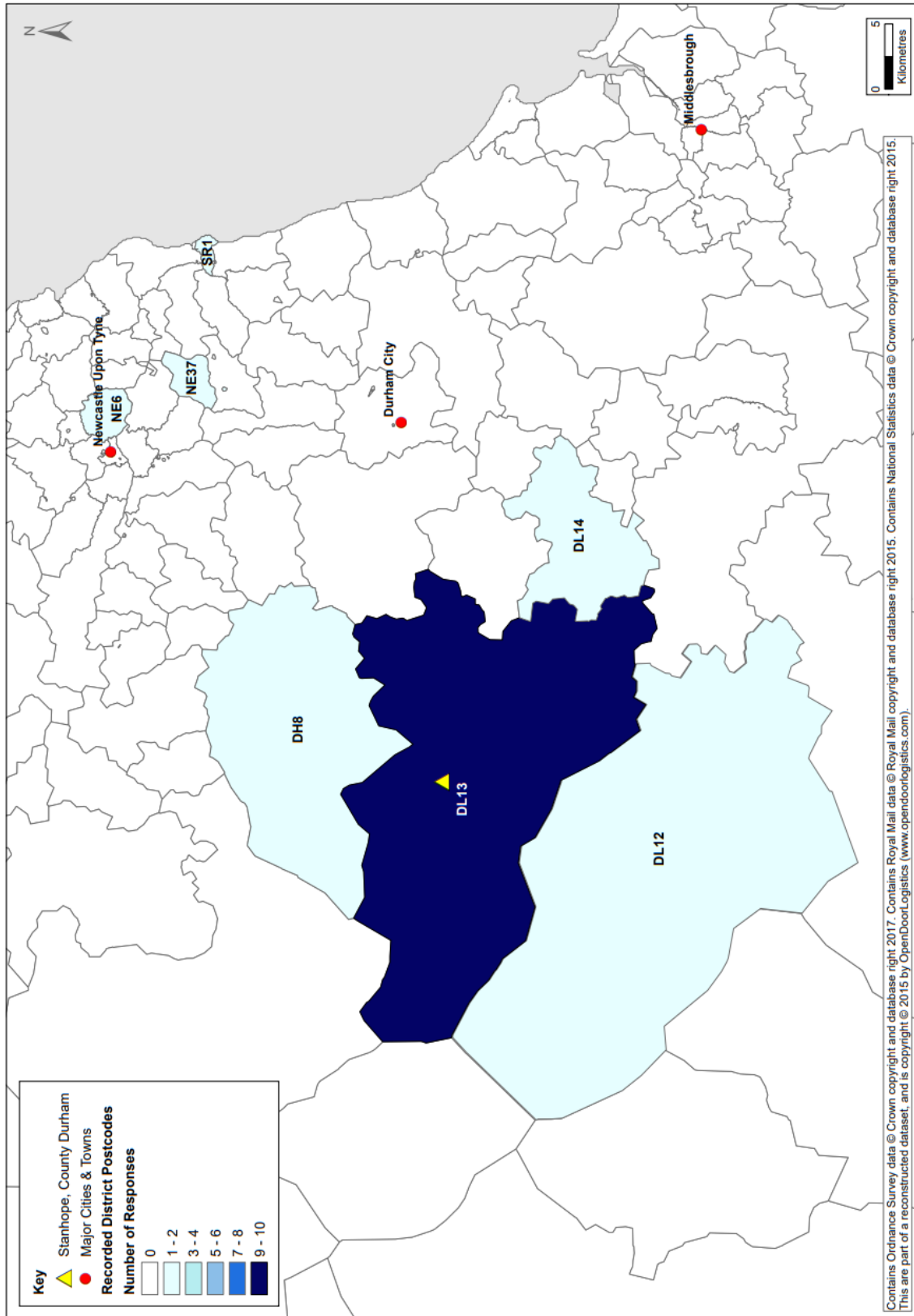


Figure 20B: Choropleth Mapping; Stanhope, Durham Dales (October 2016)

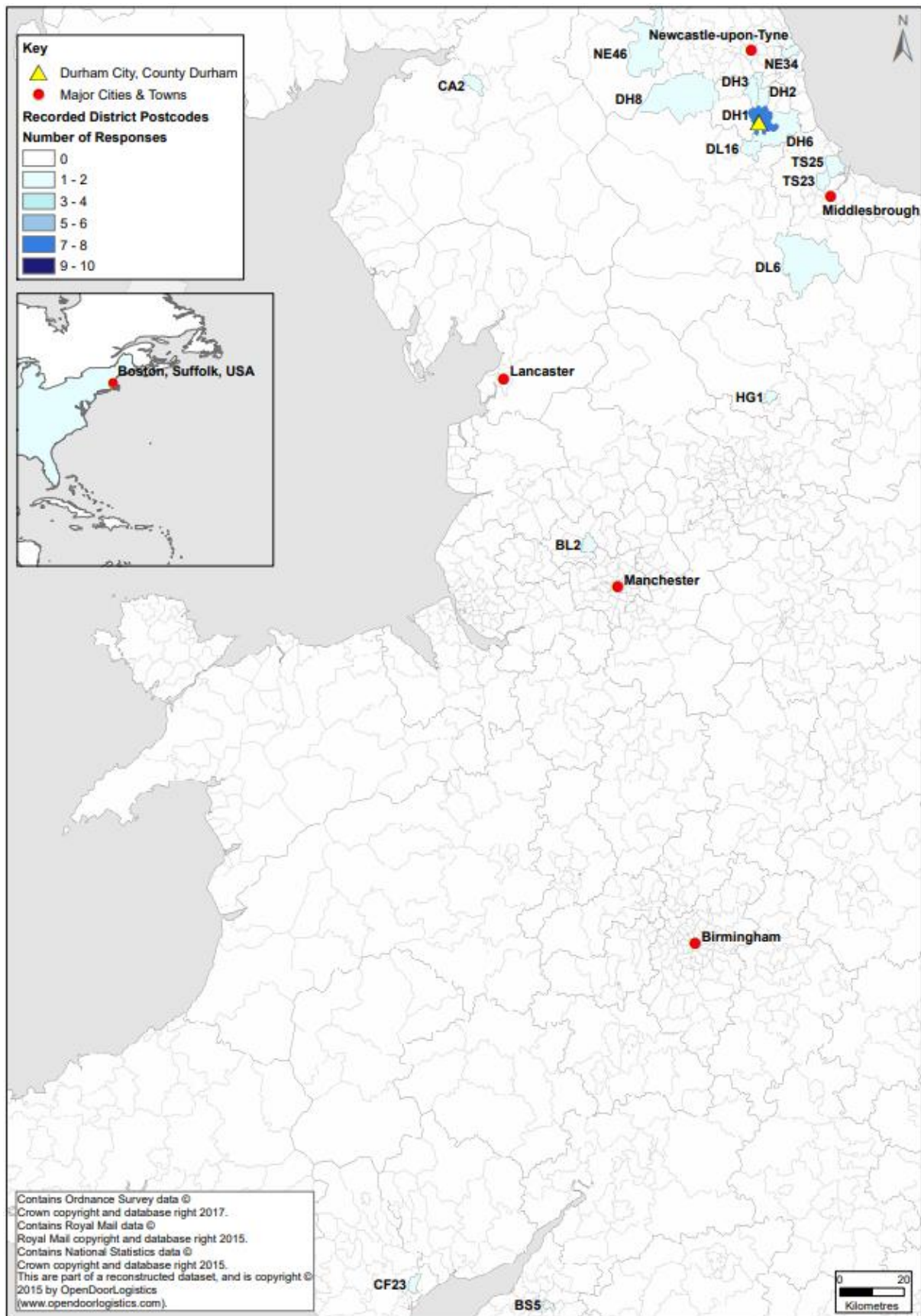


Figure 20C: Choropleth Mapping; Durham City, County Durham (October 2016)

Figure 20A presents the choropleth map for Esh Winning, and the spatial distribution of results from the data collection. The map suggests that most of the participants were from the DH7 postcode area with seven to eight responses, and a further one to two from the neighbouring postcode area DL15. From an analytical perspective, this is not surprising as I know Esh Winning to be a small colliery village. I would hypothesise that most of the participants were residents, whilst those from the DL15 postcode may have been from the neighbouring area and were using the Deerness Valley Railway Path for day-to-day use. Figure 20B provides the results for Stanhope, showing similar geographical patterns to Esh Winning; whereby the most recorded postcode area was DL13, with a quantity of nine to ten people. However, there were additional surrounding postcodes recorded for areas DH8, DL14 and DL12, which suggests some participants may have been visiting from other local postcode areas. Further afield, there were records for Newcastle-upon-Tyne and Sunderland noted, which leads me to hypothesise that these participants were in Stanhope with a more specific motive or agenda. Finally, Figure 20C shows the results for postcodes collected in Durham, showing a concentration around the DH1 area where Durham city is located. Additionally, there are darker choropleth symbolisations closer to the research site, as further afield the identified postcode areas correspond to one to two respondents. To verify these observations, it would be possible to cross-reference these findings with data collected from the questionnaire. Doing so would allow me to look at the responses for ‘reason for visit’ (see Appendix B, question 1) and observe the mode, i.e., what was the most common reason for visiting and does this support/reject my initial assumptions?

The purpose of this section is to critique choropleth mapping and explore the suitability of the method to present data collected for the PhD. Referring to Figure 20C, as the district scale needed to visualise postcodes, it was difficult to determine the postcode areas due to the visual clutter caused by boundary lines. To reduce this problem, I used the area overlay shapefile with a transparency of 50% to provide an accurate colour symbolisation for the value of zero and keep the spatial context. Additionally, one response was not a postcode area but a location, notably a plot indicating Boston, U.S.A. I had to source further secondary data to include this record; specifically, from the U.S. Census Bureau (2018). Not including it would have resulted in wrongly excluding data that contributed further information, regarding the distances some individuals travelled to be in Durham. Because of the difficulty in visualising this information, I included it as a separate inset map using colour to symbolise the entire area of the U.S. I could not include it on the same map as the results for British postcode areas, because the geographical scale would not be able to communicate all the

results for Durham effectively. If I had had more than one respondent from America however, I would have sourced a shapefile that showed a smaller scale of place, either by state or region. I selectively chose a specific geographical scale that was suitable for presenting the postcode figures, and only included information that was relevant to the resulting cartographic representation (Monmonier, 1996). As the questionnaire requested the first half of the postcode, I used the district level shapefile to present these areas and did not include an underlying base map. I felt the additional data and context would distract the user from the main purpose of the map. I did, however, provide specific geographical references in the form of major cities and towns, providing a spatial scale and context to understand where these places are (Monmonier, 1996).

The main purpose of the map was to provide a visual representation of the spatial patterns associated to respondent's postcodes, to interpret where participants had come from to be at each research site. This included the quantity of responses provided for each specific area code. To represent this information effectively, my critique of Krygier & Wood (2011) guided my design specification, using darker colour classifications to represent higher values and pinpoint an effective colour ramp using HSV colours values, to enable the user to easily differentiate between each class. I could therefore provide colours of a wider variation and use the data values to specify the range in the key (Krygier & Wood, 2011). Quite alike Bimrah, *et al.* (2010) the choropleths created can also be used to make spatial comparisons between locations, though this is currently only feasible if placed side-by-side. The restriction relates to the variety of geographical scales presented, with a risk of additional cartographic clutter. Considering further development for future study, the same side-by-side approach could be used to visualise a temporal comparison between each site, to see whether there are a greater variety of postcodes provided compared to other times of the year. I would be able to create maps that present data for each individual location and communicate postcode detail for a wide range of identified places clearly and effectively, in keeping with the map's purpose. It is, however, possible to integrate temporal data into one cartographic representation if the representative scale is consistent for each unique research location.

To summarise, I argue that function does dictate form (Monmonier, 1996). Due to the selective nature of the approach, constructing effective choropleth maps requires users to consider how best to present quantitative data through effective classification and symbolisation techniques. Krygier & Wood (2011) provide additional evidence to support Monmonier (1996) arguing that each map is dependent on the researcher's motivations, that

resulting representations are never perfect nor faultless, but are a carefully constructed attempt at communicating information. The above examples are evident of the compromises needed to make sure each map can communicate the most relevant and necessary information.

Additionally, there are risks of MAUP because I did not have the postcode details to specify location. I could only aggregate resident values to more generic postcode areas, potentially hiding further spatial trends and patterns visible at a smaller scale (O'Sullivan & Unwin, 2010). However, I did so because it was observed in the pilot study that individuals were more forthcoming to provide the broader detail. Subsequently I can protect the identity of the participant and assure anonymity, because I cannot pinpoint specific personal details like an address.

Whilst a more grounded approach would propose investigating a variety of representative scales, such as demographic factors and various spatial scales, a greater amount of detail is not always necessary nor better. In this case, I wanted to present data showing the number of responses per postcode area, not the number of responses per specific demographic group in each postcode area (Cope & Elwood, 2009). I opted for a more generic approach, rather than observing data at a smaller, more detailed scale. Quite alike Aitken & Kwan (2010), I argue that these maps are a product of effective applications of qualitative GIS and can be used as a supplementary resource. They allow for the visualisation of social statistics that can either support or contradict potential relationships between people and place, looking for patterns within the spatial overlays, to enquire 'why'? Consequently, they enable users to visualise and interpret information to better understand the potential bonds between society and space (Dwyer & Limb, 2001).

5.3 Flow Maps

Flow maps are designed to represent the movement of data from one point to another, such as the movement of people from one location to another using migration statistics and population sizes (Phan, *et al.* 2005). They present motion in relation to what Batty and Cheshire (2011:195) term the 'Lagrangian frame of reference' whereby time and location serve as fixed points and the changes between are defined as flows. Flow maps are useful for visualising these networks and transitional datasets and it is possible to indicate movement by using various symbols and representations, i.e., using directional arrows, and colour diffusion (Moody, 2009). Figure 21 provides a visual representation of population migration between California and New York (Phan, *et al.* 2005:224). In this example, the thickness of each line represents data values, these being in thousands of people, making it easy to interpret the

various spatial patterns of those who have migrated between states. It indicates the ten most favourable places to move to, suggestively that New York appears to attract more individuals from the East Coast, whilst California seemingly attracts individuals from various other regions (Phan, *et al.* 2005). However, there is an issue with this map. I cannot be sure of which direction the migration is occurring, as the map does not provide the direction of flow. It also fails to provide the reason for differentiation between the blue and green lines. I assume that the difference may be related to unique datasets, one for the New York plots and the other for California, but there is no way of knowing this by observing Figure 21.

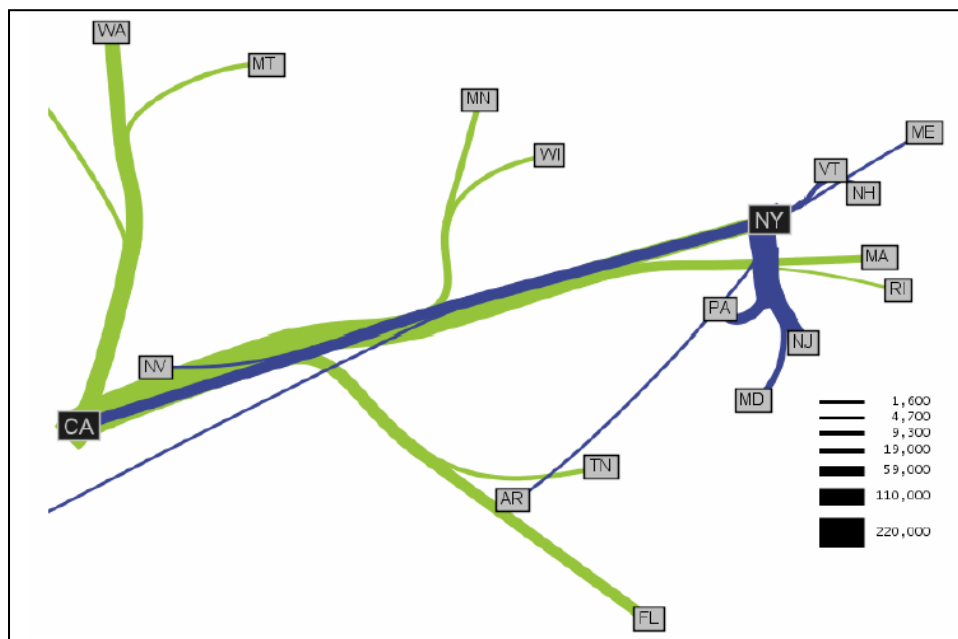


Figure 21: 'Figure 11: California and New York migration'
(Phan, *et al.* 2005:224)

An alternative flow map is observed in Figure 22 representing migration from California between 1995 and 2000, using the size of the arrowhead in proportion to the thickness of the line. Each line is plotted from a central point, in this case California, with the tips of the arrows pointing to a secondary location marked with a dot. In this example, it is much clearer to observe that the flow of migration originates in California and disperses across the U.S. to a variety of different locations. The map does not explicitly tell the user where these points are and requires some prior knowledge of the United States of America.



Figure 22: ‘Figure 1: Flow Maps. [b] Tobler’s computer-generated flow map of migration from California from 1995 – 2000’
(Tobler, 2004, cited by Phan, *et al.* 2005:219)

To critique the above two maps, there are factors and restrictions that can restrict the efficiency and capability to communicate knowledge. In both Figures 21 and 22, the user would need to have some pre-existing knowledge of America to be able to apply the necessary spatial context. Specifically, in Figure 21, further knowledge is required to decipher the acronyms used to label each of the states, whilst Figure 22 requires the reader to know where the U.S. states are. Though it is useful to already have some geographical knowledge, it is not always essential. The map creator could have provided necessary context to support the figure itself, keeping the contents clear and apparent. However, whilst these maps do not identify place names concisely, they do not have an objective to specify the relative distances between each point. The aim of each is to provide a visual representation of the migration levels between states. The maps themselves indicate the scale of migration regarding the number of people moving between locations.

Additionally, it is not possible to visualise any relationships between the movements of people and each of the data points. Researchers can only suggest motives for their movement. It is these kinds of critiques and evaluations that set the groundwork to develop another type of flow map, emphasising the need for clearer, more effective maps specifically, to incorporate qualitative data for representation (Phan, *et al.* 2005; Elwood & Cope, 2009). As such, the chapter will look to pinpoint a strategy for constructing effective flow map designs, before highlighting key design techniques that will facilitate the visual representation of data.

5.3.1 Lines, Arrows and Directional Design

There is little evidence of empirical study, nor availability of a guidebook, that specifies the correct approach to design flow maps (Jenny, *et al.* 2016). The following section will be split into three categories of discussion. The first regards ‘A Strategy’ where I observe the construction of flow maps and the representation of flow data, an evaluation of Phan, *et al.* (2005) who argues for a clear approach to the map design process, and the necessary spatial aspect, considering the representations of quantitative data. The second part highlights ‘Key Principles and Design’ regarding aesthetic qualities for effective visualisations, observing Jenny, *et al.* (2016) on ‘design principles’. I will explore key information about the formulation of flow map data visualisations, referring specifically to the clarity of cartographic design, the representation of flow data from an aesthetic lens, and effective, accurate information communication (Phan, *et al.* 2005; Jenny, *et al.* 2016). Consequently, the section will move to the third part to discuss the strategy devised from the critique, and how best to incorporate design attributes to create a different type of flow called a ‘Postcode Plot’.

- A Strategy

The process of design acknowledges the main aim and purpose of the flow map, whether this is the overview of flow maps generically, or the objectives of specific data representations (Batty & Cheshire, 2011). Flow maps are characterised by their need to communicate information visually, hence the effectiveness of each visual element is paramount to its success (Phan, *et al.* 2005). Specifically, each element must correspond to a clear legend/key, with clear instruction of the data values that the elements represent. The process of design should consider the dataset first, this being the series of points, where each will need to be plotted, and the direction of flow (Phan, *et al.* 2005). The approach must be strategic and systematic. Each stage must be completed properly to facilitate and support the next step. For example, Phan, *et al.* (2005) explains the necessity to consider the layout of the entire map and how the finished product will look, so that the initial visualisations can be generated for review. Once the layout has been adjusted and the initial clustering of information has been processed and confirmed, it is possible to associate the ‘spatial layout’ (Phan, *et al.* 2005:220). Some flow maps need to represent more than one flow network, whereby multiple maps can be presented through one cartographic form (Phan, *et al.* 2005). However, this is only possible if the context and locations match, i.e., it would not be suitable to show a flow map of London, against a flow map of America, because they are on different scales and in different locations. If the research required a flow map of Durham, it would be possible to layer flow map data depicting the movement of visitors, residents, and students, on top of

secondary data sources such as census and social statistics. The information for each demographic is required to enable a comparison between the census and flow data. I would need to be selective and only present the necessary detail.

The spatial aspect of the map begins with a contested discussion about whether there is a need for flow maps to have some form of base map, something for the data to sit on and provide the spatial context. In some cases, they are not necessary, such as Figure 21 by Phan, *et al.* (2005), as the map did not need to provide indications of the distance between each of the settlements, only plot geographically correct points. Another example is the below Figure 23 by Kirk (2016:206) regarding vehicle usage in Hong Kong, China, 2011. The flow data is made up of the average number of vehicles using the road networks around the city, mapping the average number of vehicles in comparison to the previous year. There are no directional arrows or linear indicators as the designer has used the road networks to indicate areas of movement. There was no desire to focus on a specific travel direction, more refer to movement as a general theme. This is a clever technique that supports the overall concept of the map using the transport systems to provide the spatial reference and indicate the areas of investigation. Similarly, the road networks are fixed to specific spatial references and location. Once mapped, they can be used to identify geographical areas, such as the grid pattern in the centre of the illustration indicating more built-up areas, and the windy, snakelike roads that appear to wind themselves around the extremities of the city and into rural areas. Additionally, Figure 23 has a map legend for identifying symbology, and a second table that breaks down the aggregated data further. Though this information is not represented on the map itself, it does provide additional context and smaller scale detail. Specifically, the average traffic figures are calculated by adding up the total number of vehicles licensed in 2011, such as motorcycles, private cars, goods vehicles, and government vehicles. The percentage change between each type of vehicle is also calculated and symbolised within the matrix (Kirk, 2013).

Arteries of the city

As Hong Kong becomes ever more affluent, the number of people with cars continues to increase. The Transport Department has released its Annual Traffic Census that records the number of vehicles on each of the city's roads. The *Post* has analysed the data and mapped out traffic levels to show how the network keeps us all moving.

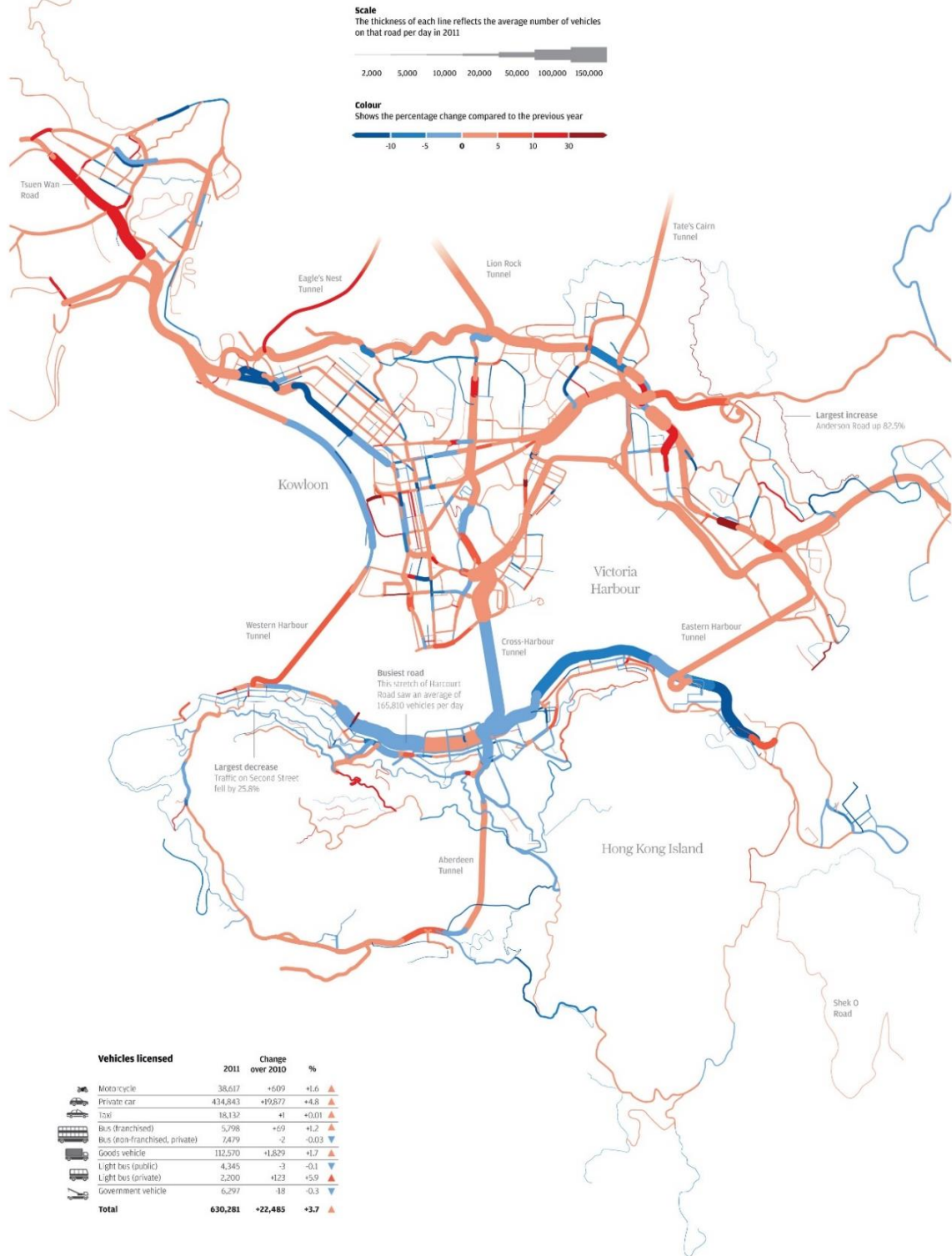


Figure 23: 'Figure 7.53: Arteries of the City'
(Kirk, 2013; Kirk, 2016:206)

Having understood the approaches taken by Kirk (2013, 2016) and Phan, *et al.* (2005), a base map is not an essential part of map product. It does require an accurate spatial scale, whereby users should still be able to interpret distance between points and pinpoint locations from the layout. The ‘spatial layout’ refers to the placement of the dataset, specifically where each node was plotted and where they ‘branch out’ to their end destinations (Phan, *et al.* 2005:221). These branches are a vital visual element for the map design as they symbolise the direction of data, but these must also add an aesthetic quality to the flow map. In some examples, these branches often overlap and intersect one another depending on where they originate and are plotted to. Similarly, if trying to plot more than one flow network, it is not possible to overlay more than one dataset without any conflict between lines and nodes. It requires sorting out how best to differentiate each set flow of data to make the visualisation clearer and more user friendly. The challenge is how best to do so and minimise the number of intersections, whilst ensuring clear symbolisation in the map’s legend (Phan, *et al.* 2005). Each node is fixed to a specific point and cannot simply be moved if it is either in the way or hidden by other sets of data (Jenny, *et al.* 2016). Additionally, computers tend to calculate and identify the shortest distance to two points, using the easiest route to link two nodes together to calculate and determine distance. This can be problematic for flow maps as distance is not necessarily the important variable to include, where the focus is on representing the direction of flow.

- Key Principles & Design

My initial concern with the construction of a flow map for the thesis was ensuring that I could get all the detail and information I wanted into one representation. Origin-destination flow maps provide a visual representation of the flow between points and require effective aesthetical decisions to make sure that the information is easy to access and communicate. To ensure this, the following section focuses on three design elements that are key to representing flow: direction indicators, line width and colour classification, and line arrangement and style.

Direction Indicators

Though these are often outlined in a figure caption or within the main body of text, arrowheads are commonly used as a familiar, well-known method for indicating direction. Tapered arrows utilise size to represent direction by changing the width of the line from start to finish; the wider part of the line at the start with the thinner end at the finish, and replicable of an arrowhead shape (Holten & van Wijk, 2009). There is, however, debate about the effectiveness of their use. On one hand, arrows can arguably influence ‘contradicting

conclusions' and should not be used at all (Jenny, *et al.* 2016:3). Holten, *et al.* (2011:195) explain that by using several arrowheads to represent the direction of flow, maps are more likely to suffer from 'visual clutter' due to overlapping. It would be difficult to interpret where point each arrow finishes, therefore increasing the risk of inaccurate information interpretation, and hindering conclusions. On the other hand, there are other methods for indicating direction of flow; colour gradient/hue (i.e., light to dark lines), colour use (i.e., blue to red), or numerical/alphabetical sequence (i.e., numbering points from one to two; labelling 'A' to 'B') (Holten, *et al.* 2011).

Line Width

Netzel, *et al.* (2014) argue that tapered width can cause a misinterpretation of quantity, so its use is dependent on the research context and clarity of key. To visualise more complex networks of migration, the tapered arrow style may not be appropriate, i.e., the wider end of the line may suggest a higher number of people whilst the thinner end of the line represents fewer. Jenny, *et al.* (2016:4) suggests that for visualising variables, line width is the most used representational tool because of their capability to present 'moving volumes'. Tobler's map above on migration from California uses this method to represent the volume of people, but he also uses arrowheads in proportion to the size of the arrow (Tobler, 2004, cited by Phan, *et al.* 2005:219). This ensures that the arrow heads do not mask or hide the other directional flows, making sure to balance and adapt the map for full visual clarity (Phan, *et al.* 2005). Kirk (2013) also uses this method, whereby the thickness of each line corresponds to the average number of vehicles on the road in 2011, though he does not use any type of direction indicator which limits the identifying of movement between specific points.

Line Arrangement and Style

Line arrangement is also a key principle to consider. The lines should be the most predominant feature on the map requiring a selective approach to visualising only the necessary and relevant information, manually choosing which attributes need to be represented or not (Phan, *et al.* 2005). However, the line style depends on the type of flow map, whether presenting multiple flows to several origin-destination sources, or dependent on one origin source with multiple destinations (Phan, *et al.* 2005; Jenny, *et al.* 2016). Too many lines can restrict access to the story been presented, making the figure too complicated to interpret and difficult to make sense of the data; whether these are intersecting or there are simply too many included on the map (Becker, *et al.* 1990; Becker, *et al.* 1995). Jenny, *et al.* (2016) suggests that a large quantity of designed and published flow maps do not have lines

that intersect at all, with Moody (2009) supporting that this is the correct approach to representing flows. Each symbol should be easily distinguishable from the rest, both in the map legend/key and on the map. Additionally, flow maps and their linear representations should not have any angles because these can often suggest direction (Jenny, *et al.* 2016). On the other hand, these angles may be necessary depending on the scale of the investigation. If a researcher wants to plot the actual journey made by a person between two points, then angles are an inevitable factor (see Kwan, 2008).

For this research project, I wanted to observe travel distance on a large, more generic scale, i.e., the number of people who travelled between two specific postcode areas. To do so, I examined the work of Jenny, *et al.* (2016) and critiqued the line arrangement and style observed in Figure 24 below. The focal point of the two flow maps is to present the flow of goods around France 1998, centralised around Paris with much of the goods being sent further south to Marseille, Perpignan, Bordeaux, and so on (Jenny, *et al.* 2016). It is also possible to observe additional movements between other locations, Lille and Strasbourg, Nantes, and Marseille, whilst the thickness of the flow lines represents the quantity of goods moving between each of point (Jenny, *et al.* 2016). The necessity for clarity and clear design aesthetics is more prominent in this example, as it provides two different types of flow line representation; curved and straight. The straight lines symbolise more direct movement between locations and appear to merge around the central point. This makes it difficult to interpret any movement between other points (i.e., Strasbourg and Bordeaux). The curved lines on the other hand, provide more distinction between each line of flow making each movement much clearer and accessible for interpretation and analysis. In this case, the curved lines provided better symbolisation of data because each line can indicate the goods movement to/from locations with minimal visual restriction (Phan, *et al.* 2005). Furthermore, the figure provides the necessary spatial context and provides access to the spatial layout of the map. Here, users can grasp the national scale of such processes, the distances that goods can cover, but also understand the relationships between key locations, i.e., that Paris is the capital of France, therefore more likely to receive and distribute large quantities of manufactured goods.

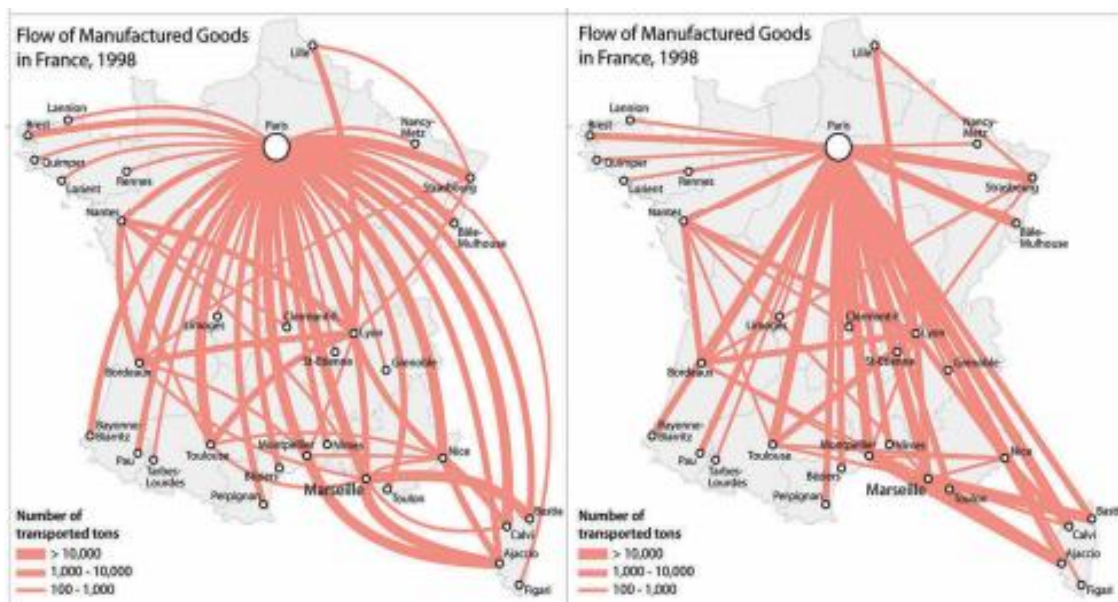


Figure 24: ‘Maps with curved and straight flow lines’
(Jenny, *et al.* 2016:7)

Some cartographers and data visualisation designers argue that there is no such thing as a straight line. The world is a sphere, and the line of flow should represent such. Map projections can distort and exaggerate these symbols because distortion is used to explain the curvature of the earth, such as the Mercator projection which changes and alters the way shapes and land mass is visualised towards the north and south poles (van Wijk, 2008). On the other hand, this distortion is often manipulated by cartographers to differentiate between each line of flow, whereby the above do not need to use map projections to be geographically accurate, they need to be able to communicate spatial layout and scale to the user. However, curved lines may be misinterpreted as flight paths which is why clear titles, subheading and captions are also necessary. Furthermore, ‘cartographic license’ lies entirely in the assumptions portrayed by the data representations, so I could design a map that required more simplistic representations of information rather than the geographic correctness (Monmonier, 1996:61). This cartographic license allows cartographers and researchers to adapt, change and develop data visualisations to fulfil the needs of their research, whilst bearing in mind the strategy to do so and the association of key design principles.

Considering these critiques and discussion, Phan, *et al.* (2005) and Jenny, *et al.* (2016) have provided clear suggestions on how I should approach the creation of my own flow map designs. With an aim to visualise the flow of movement between areas of residence and specific cultural heritage sites, the Postcode Plots are designed to present indications of travel distances covered by individuals to each research location. They are designed based on the

provision of postcode data as a visual aid or supplementary resource, for investigating the relationships between individuals and place. They enable researchers to visualise locality and the spatial context between the point of origin and destination.

5.3.2 Postcode Plots

Beginning with the data collection, I used the questionnaire to collect postcode data from willing participants, to plot and visualise this information in relation to each research location (see Appendix B). I then considered the layout of the map, being where I was going to plot my collated postcode data and how best to situate the indicators of flow. The spatial aspect was implemented by considering Phan, *et al.* (2005) whose mapping designs do not have a base map nor backdrop map because the detail was not necessary, though point data was still used to identify key locations to map users, such as cities for use as location references (Kirk, 2016). In the provision of a spatial scale, like Jenny, *et al.* (2016), each flow map contained boundary data to provide the necessary detail and context.

On the other hand, each postcode area is geographically restricted by a set spatial reference, whereby each postcode area differs in terms of the amount of space it covers. Considering MAUP (see O'Sullivan & Unwin, 2016) the detail regarding where individuals were specifically from was removed, so it appeared that people from the same postcode areas had travelled the same distances. This was a very different story that I was simply unable to tell. This generalisation process also caused an issue where I could not link node to node. As I only had records of postcode areas to plot the data to create an origin-destination map, I had to calculate the centre or centroid of each shapefile to provide a pinpoint for each line of flow. These points were then used to calculate an 'as the crow flies' distance, to work out the distance travelled and exaggerate the finds for visible interpretation. They are an approximation, not a representative figure for actual distance covered.

Being a small-scale project, the design principles observed previously were useful to implement within the visualisation process (Jenny, *et al.* 2016). Specifically, direction of flow was not an essential visualisation requirement, so arrowheads were not used to provide this indication. When it came to line arrangement and line styles, these were notably the most predominant feature of the map because they had to present the movement of people. I therefore aimed for minimal overlapping to ensure clarity, again without the use of angles to differentiate lines to prevent further misinterpretation of information (Becker, *et al.* 1995; Becker, *et al.* 1990; Jenny, *et al.* 2016). Referring to the curved vs straight line debate, curved

lines appeared to better facilitate the representation of flow by allowing the user access to both the spatial scale and layout. However, these maps did not need to be geographically accurate regarding projection. Using the distortion would have made each line clearer and better to differentiate and identify (van Wijlk, 2008), but as each line of flow related to travel distance and there was minimal cluttering, I did not incorporate this.

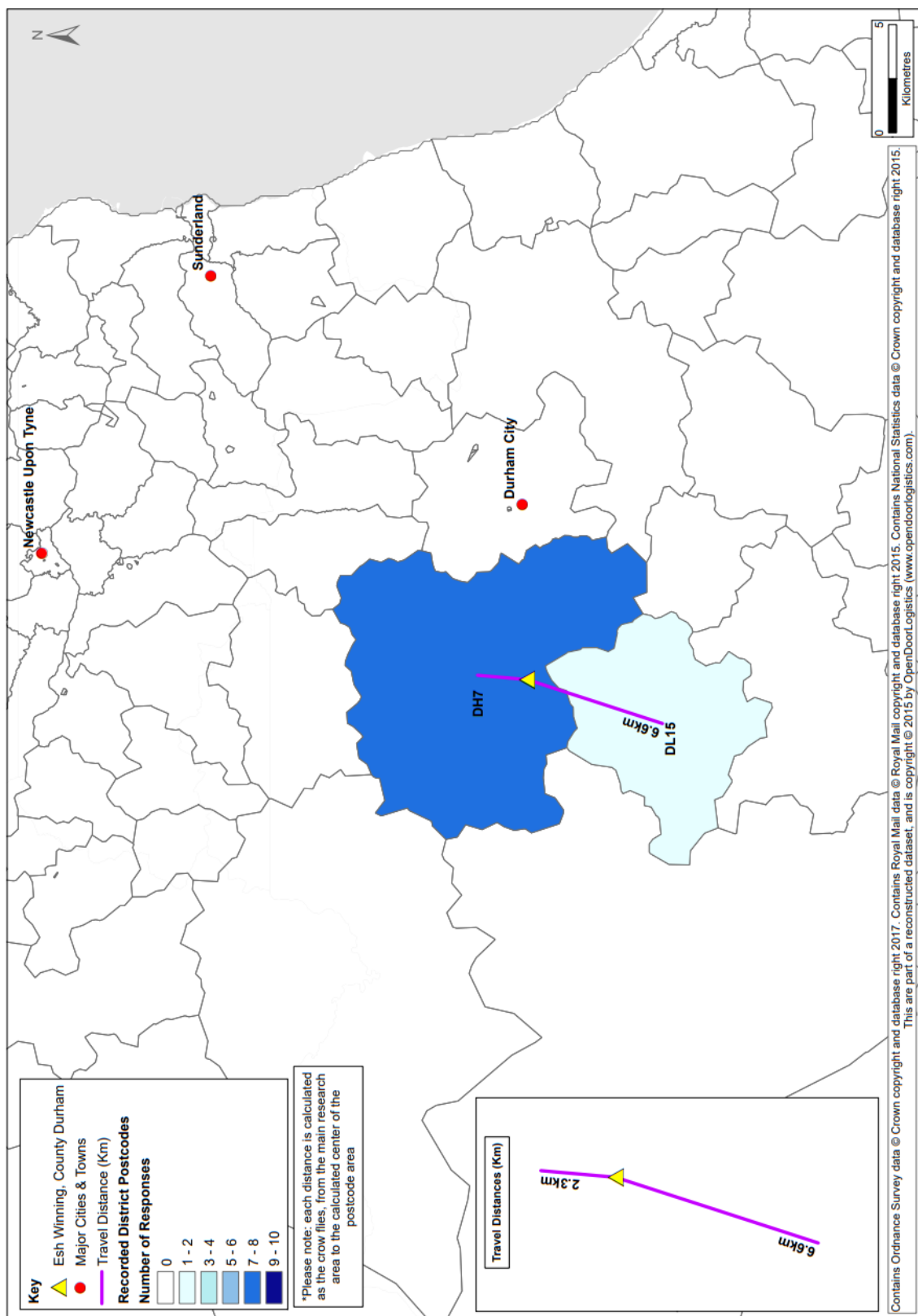


Figure 25A: Postcode Mapping: Esh Winning & the Deerness Valley Railway Walk (October 2016)

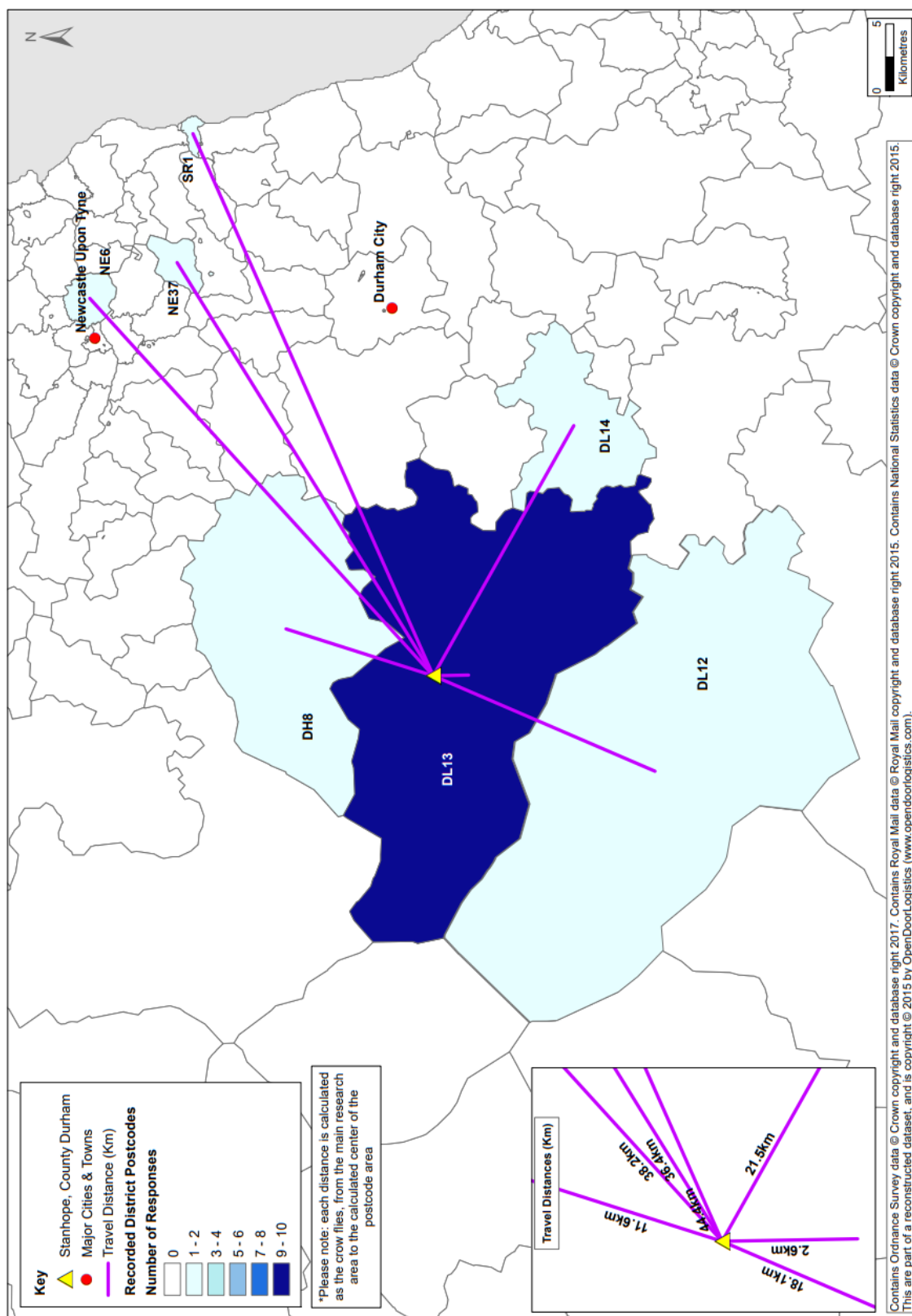


Figure 25B: Postcode Mapping: Stanhope, Durham Dales (October 2016)

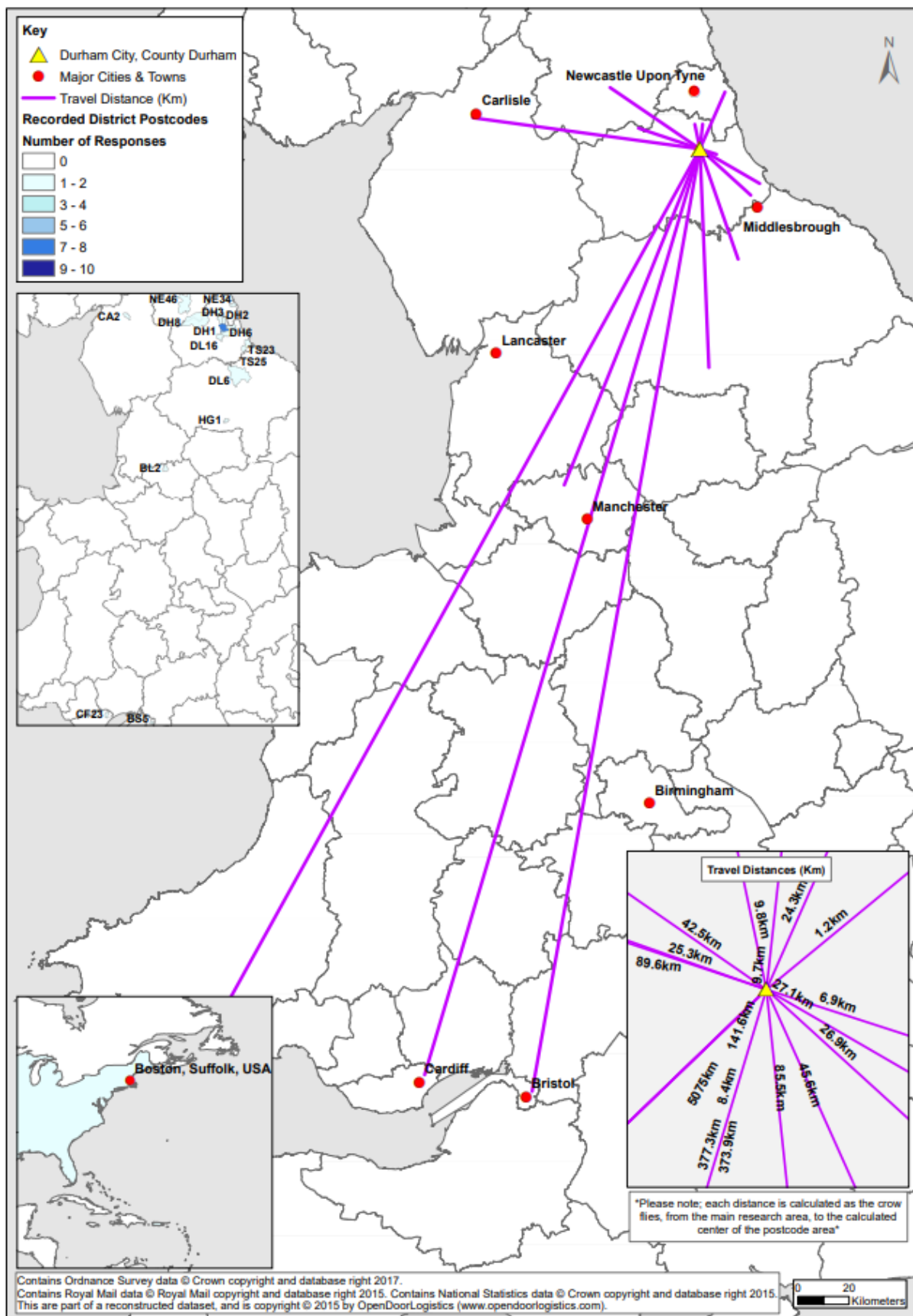


Figure 25C: Postcode Mapping: Durham City, County Durham (October 2016)

Figures 25A-C each present a Postcode Map generated to present the travel distances between participant's homes and either of the three research sites in October 2016. Figure 25A shows that the mode postcode provided by participants in Esh Winning came from the DH7 area with a calculated travel distance of 2.3km covered. DL15 on the other hand, was the only other postcode recorded, with participants travelling 6.6km as the crow flies. Figure 25B provides a visual representation of the data collected from Stanhope. The most recorded postcode was DL13, which is the area Stanhope is located in. Other identified postcode areas included DL12, DH8, DL14, NE6, NE37 and SR1, SR1 being a Sunderland postcode with the farthest distance of 44.4km calculated. Figure 25C provides the third cartographic representation for data collected at the DCP points on Durham peninsula. The largest recorded travel distance was 5,075km calculated, as one participant travelled from Boston in the USA, to visit Durham City. There were however several other postcodes provided by participants, with a plotted concentration appearing around the DH1 area for Durham city centre. Consequently, the most noted postcode was the DH1 which may be due to several respondents having been residents at the specific time of the year. It could also be the result of students who lived in Durham, having provided their term time addresses rather than their actual home residences. This has potential to influence the spatial trends and patterns observed because there are now additional complications regarding how these individuals may have interpreted the questionnaire; those who did state the postcode they had travelled from that day, versus those who provided a temporary postcode.

By implementing a strategy and incorporating key design attributes for the visualisation process, the result was a series of flow maps that are consequently a product of good visualisation design. They are 'trustworthy', 'accessible', 'elegant' in aesthetic quality (Kirk, 2016:30). They enable users to visualise the distances participants have travelled to visit specific cultural heritage sites and meet the design objective. To highlight a restriction and/or limitation, these maps contain inaccurate and incorrect spatial scales because some content has been exaggerated purely for visualisation purposes (Phan, *et al.* 2005). Specifically, the calculated distances presented in Figures 25A-C do not suggest journey paths nor are they representative of the actual distances that participants travelled. The information provided did not allow me to map specific journeys, hence I could not calculate a more accurate travel distance. As a result, these maps are an effective resource to be used as a supplementary source of information. They allow users to interpret additional context and spatial understanding visually, such as the proximity to surrounding major towns and cities, road networks and rivers (Monmonier, 1996; Phan, *et al.* 2005). I made a compromise to make

sure that I could collect some relevant detail and create a snapshot of a story from the collated data, whilst still protecting the confidentiality and anonymity of the participant.

To conclude, the aim of Postcode Plots was to emphasise the use of flow maps, by depicting distance data and other types of quantitative data sets in cartographic form (Smits, 1999; Phan, *et al.* 2005; Jenny, *et al.* 2016). They are designed to show the movement of visitors from their areas of residence to specific cultural, heritage sites, whilst providing an indication of the distance travelled in kilometres (as the crow flies). However, there was a risk of visual cluttering restricting the clarity of the map, so colour symbolisation was also applied to the boundary data. The concept of doing so was taken from the previous section on choropleth mapping, where aggregated data was assigned a colour classification with paler shades representing the lowest values, and darker shades representing the highest (Krygier, *et al.* 2011). It combined the key purposes of both flow maps and choropleth maps into a new conceptualised data visualisation type (Phan, *et al.* 2005; Krygier, *et al.* 2011), to enable users to visualise the distances that individuals have travelled to get to certain heritage sites, alongside the number of respondents from each postcode area. Furthermore, it is now possible to query and hypothesise why some individuals may have travelled greater distances than others to a well promoted, popular area like Durham city, or why participants were seemingly only from surrounding local areas including less well-known landscapes and smaller communities like Esh Winning.

5.4 A Discussion

The purpose of this chapter has been to investigate data visualisations that are characterised by more detailed, more complex databases and spatial quality. These types of representation are designed to graphically present summaries of data, using cartographic representation to interpret the relationships between geographic phenomenon and space (Kirk, 2016). Their aim is to provide a visual representation of spatial patterns using both quantitative and qualitative data, enabling the user to interpret and describe their findings through a visual analysis. I have provided two different cartographic representations, a choropleth map, and a postcode flow map, that show it is possible to adapt and tailor-make visualisations for specific purposes and specifications, by engaging with key corresponding concepts and approaches.

Primarily, choropleth maps define geographic boundaries and observe social phenomena through aggregated categories of data across specific spatial scales (Bimrah, *et al.* 2010). The constructed cartographic representations do this by presenting the frequency of postcode

responses at district level in relation to associated geographical boundary. Flow maps were used to present movement between origin and end destinations, to visualise networks and transitional data and incorporate spatiality, whether as part of the data aggregation, or the physical application of scale as an attribute for cartographic representation (Phan, *et al.* 2005; Jenny, *et al.* 2016). The Postcode Plots specifically can depict travel distance to visualise locality and understand the spatial context of participant's experiences of cultural heritage sites, such as purpose of visit and levels of familiarity. They incorporate the design principles to produce trustworthy and accessible maps and provide evidence to support the use of visual tools (Monmonier, 1996; Phan, *et al.* 2005; Jenny, *et al.* 2016; Kirk, 2016).

In this research project, choropleth and flow mapping have been used as exploratory research tools to provide incentive and prompt further investigations about social, spatial, geographic phenomena. Though the categorical mapping examples observed in Chapter 4.0 have been identified as effective supplementary resources, I argue that spatial mapping representations are able to take this one step further. They allow researchers and other users to not only search for further context, but prompt additional how and why queries from the interpretation of data visualisations (Brown, *et al.* 2015). I propose that to do this, cartographic representations require a degree of creativity to communicate knowledge in more vibrant and aesthetically pleasing ways. Specifically, applying cartographic license allows cartographers and researchers to develop and adapt various types of representation to support their own unique purposes and research design specifications. The computational and technological capabilities of GIS have resulted in the desired cartographic representations, approaching the methods from a mapping context to supplement investigations regarding perception and landscape interpretation.

An effective strategy is necessary to create representations that can communicate qualitative and quantitative data accurately and clearly function as an exploratory research tool. Each of the three map types have unique specifications with corresponding principles that enable them to function as effective forms of data representation. For example, choropleth design requires three key attributes (value, legend, and boundaries) to indicate purpose and provide necessary context to understand the visualisation (Krygier & Wood, 2011). The map legends are a vital communication tool for providing accurate and concise from an identified symbology, as they can also be used to specify further detail (Kirk, 2016). Similarly, each mapping type factors in clarity and selectivity as key qualities to present only what is necessary to the research investigation. The limited availability of concise instructions and guidelines has raised the

initial ‘how to’ question and fuelled this research investigation (Monmonier 1996; Yau, 2011; Kirk, 2016). The mixed methodological approach has accommodated the need for computational power and enabled technological processing through GIS, having linked qualitative to the quantitative and provided a clear symbology to communicate description and meaning visually. Achieving this, spatial charts, and the patterns they present can provide supplementary strength through effective design and representation (Robinson, et al. 1995; Sun, et al. 2013; Sun, et al. 2015; O’Sullivan & Unwin, 2016). By adhering to a specific strategy and associating key conceptualised frameworks, the resulting maps incorporate themes of imageability and perception, enabling this research to investigate the engagement between individuals and cultural heritage sites (Lynch, 1960; Ewing & Handy, 2009; Cooper & Gregory, 2010; Brown, et al. 2015). It required a systematic and sequential approach to the data collection, to combine structural components with more meaningful ones, to develop a more rounded story through data representation (Lynch, 1960; Elwood & Cope, 2009; Ewing & Handy, 2009; Cooper & Gregory, 2011; Travis, 2015).

Referring to flow maps specifically, these must address and engage solely with their purpose to either provide an indication of direction, or indication of movement (Batty & Cheshire, 2011). In my critique, I found their capabilities to present more dynamic datasets reinforced a greater need for clarity and a selective attitude towards data representation. However, the presentation of movement (not direction) in the Postcode Plots highlighted the risks that cartographic clutter can create, whether by including too many icons, too many data categories, and/or too much spatial context from provided basemaps and geographical references. This is another key factor to consider when making visual comparisons between maps and is only possible if the maps contain clear layers of data of the same spatial scale. I argue that visual comparisons may be better analysed and studied through side-by-side comparisons, designing maps of the same calibre and scale to reduce the effects of visual cluttering, restricted communication, and misinformed accuracy. It also enables cartographers to replicate the same spatial scales and view different variable/categories of data alongside one another, to visually interpret any potential trends and correlations that emerge from the data visualisations (Bimrah, *et al.* 2010). Thus, each of my maps have been created with this motive in mind. Identified categories and emergent themes of data are presented independently, to reduce the risk of complication and misinterpretation. By keeping my own maps more minimalistic, it has been possible to ensure that content is accessible to the user, and available for clear communication and visual analysis.

However, the limitations of these spatial representation link not only to problems of MAUP, ecological fallacy, and scale, but to more specific problems and constraints (O'Sullivan & Unwin, 2010). The numbers are not representative of value, they are an aggregate of frequency/counts used to process qualitative data and create data representations for visual, exploratory means. Moreover, each of these representations cannot communicate reasons to explain 'how' certain phenomena has occurred, nor 'why' certain trends and patterns emerged through data visualisation. They can only present proposed relationships between variables, and not facts, i.e., flow maps may suggest movement and direction with the necessary detail, and choropleth can portray spatial patterns from within categorical sets of data. I do however wish to reinforce that each of them can be used as an investigatory tool to view these potential relationships between themes/concepts and place, but on the basis that the findings are dependent on the interpretation made by the user.

This leads me to approach an evident reliance on space, not as a theoretical concept but as a spatial unit or scale. Quite alike the aggregation process, the analysis required engaging with a spatial context, extracted numerically to create representations that could communicate spatial trends and correlation (Skupin & Fabrikant, 2003; Sun, *et al.* 2015; Rucks-Ahidiana & Bierbaum, 2017). Specifically, for both choropleth and postcode mapping, I was able to visualise spatial patterns of qualitative data by layering information onto basemaps (i.e., OS Survey Data or boundary outlines of regions). It is a technique that allowed me to map information in direct association to space, providing a foundation layer for observing humanistic perceptions cartographically and interpret the relationships between people and place. However, quite alike the aggregation issues noted previously, scale can mask, over-generalise, and exaggerate data representations especially where information is missing, or finer details removed in the quantification and manipulation process (Monmonier, 1996; Phan, *et al.* 2005; Jenny, *et al.* 2016). Data can be skewed and communicate misinformed findings, so the cartographic representations must be responsive to this limitation, i.e., the ethical restrictions regarding postcode data collection.

Furthermore, spatial context requires further cartographic detail to be able to associate spatiality and scale in the final mapping product. This is often context-dependant, especially where users do not have access nor full transparency of the meanings being communicated through the data visualisation, i.e., acronyms and labels, relying on user's being able to decipher place names (Phan, *et al.* 2005). In some cases, this context is not necessary. From a design basis, whilst base maps encompass a literal representation of location, they can hinder

the communication of layered data and resulting trends and patterns (Holten, *et al.* 2011; Clayson, 2015). In other examples, a boundary outline or key location data (i.e., major cities and towns) are suffice in providing geographical context for users to access the maps scale and spatial reference. However, a spatial reference relates to more than the provision of a data file or basemap. It is an attribute that must be considered throughout the methods and representational processes, from the data collection and methodological strategy, to analytical tools, key geographical references, and data communication. Doing so effectively can enable users to map information geographically for symbolising and presenting cartographically.

Chapter 6.0 Experimental Mapping Categories

6.1 Creative Spatial Explorations

Yau (2011:44) suggests that visualisation is not just a tool, but a ‘medium’ that provides ways of exploring, presenting, and expressing the meanings of data. Whether in the form of graphical representations or cartographic examples like those explored in Chapters 4.0 and 5.0, they are designed to contribute to the research enquiry and fuel motivation for investigation as opposed to simply revealing the already existing trends from within the data sets. This chapter will investigate three other visualisation techniques that utilise a spatial attribute in different ways and to various degrees. It considers a more creative, experimental exploration of data representation, specifically the structure, content and meaning of the data sources used to create each data visualisation (Knowles, *et al.* 2015), whilst highlighting the need to acknowledge, integrate, and associate any necessary spatial reference throughout the design process, to ensure that the resulting representations are an effective form of data visualisation.

As explored previously in chapter 2, in the context of this research, data visualisation encompasses data graphics and cartographic representation⁶⁹ as a means for presenting a variety of information, regarding their dependency on geographically referenced data. In this chapter, I propose the potential to combine data graphics with cartographic representations and visualise the relationships between people and place, considering these as additional tools for mapping perception of place. Though the objective of data graphics⁷⁰ is not to provide geographical representations of data, nor address any form of spatial context or reference, I argue that they can be used to visualise patterns within qualitative datasets as a supplementary resource. I explore the use of data graphics from a cartographic perspective and investigate the designing of three different visualisation products, termed ‘Cartographic Word Clouds’, ‘Likert Maps’, and ‘Sankey Diagrams’. Each one has been created by associating a spatial attribute either through the integration of various data visualisation methods, or by layering infographic data onto various maps (Kirk, 2016). They highlight the importance of associating this spatial aspect, to develop methods of data visualisation that combine the motives for graphical representation with cartographic representation.

⁶⁹ See Chapter 2.0 section 2.3.2 Data Visualisation

⁷⁰ Here, I am referring to categorical, relational, and temporal charts that can present categories of data, relationships between variables, and trends occurring over time (Kirk, 2016). Spatial charts are discussed in relation to cartographic representations.

The first visualisation, Cartographic Word Clouds, associates a spatial attribute to a qualitative data set by linking a word cloud to a spatial reference for mapping. Considered a categorical representation of data, word clouds are evidence of the possibility to incorporate a spatial context to this type of representation. It is possible to associate relational qualities to the cartographic representation by layering clusters of collected words on top of a base map, to view the connections between the word cloud and surrounding environments. However, the loose association of this spatial reference leaves the resulting map rife with issues and limitations, including accuracy and validity; challenges that I will suggest potential resolutions for.

The second mapping example, Likert Maps, present qualitative data sets (i.e., opinions and perceptions) in cartographic formats, by quantifying interpretations of landscape through categorisation and aggregation. Specifically, these maps provide a format for visualising potential relationships between people and place, through a visual, spatial analysis of their interpretations of specific places. To investigate these further, additional usability testing was carried out to find out how effective the cartographic representations were for presenting people's emotions, feelings, and responses.

Finally, Sankey Diagrams are explored as a third form of data visualisation. Whilst data graphics can present a variety of different data dimensions, removing any association to a spatial attribute or reference prevents them from visualising geographical patterns and trends within data sets (Kirk, 2016). By utilising Sankey diagrams to present quantitative and qualitative data, I provide evidence of their capability to visualise information pertaining to landscape perception. By using survey data, the representations communicate the flow of answers from one question to the next, through a more creative representation. However, the observed patterns and trends cannot be used in conjunction with specific spatial scales. I created these presentations by aggregating detail to corresponding research locations, to create a consensus about each of the cultural heritage sites. These representations cannot be used as evidence to support observations based on micro-scale representations of place (i.e., about specific streets, landscape features, or landmarks), as the questionnaire did not specify or ask for perceptions regarding unique environments or settings within each research location (Bimrah, *et al.* 2010).

6.2 Mapping Relationships and Connections

Each of the three representations that I have investigated, developed, and critiqued have the same purpose and objective, to communicate representations of qualitative information and emerging geographical trends and patterns. Kirk (2016:158) refers to these types of data visualisations as ‘relational’ chart types, because of their ability to present the connections between categories of data. They have an ability to graph the relationships and associations between various factors and visualise the potential correlation within datasets (Kirk, 2016). Considering the strategies and techniques required for mapping the relationships and connections between people and landscapes, I have investigated how each data visualisation implements a spatial attribute, whether this was incorporated in the data collection methods and/or the design process, to produce the resulting data visualisations. By achieving this, I can use these representations to understand the bonds and connections that individuals formulate with cultural heritage sites and investigate the reasons why people develop relationships and place values on specific landscapes. The aim of the analysis is to provide the visual and spatial capacities to tease out the associated meanings and resulting knowledges, to provide further supplementary context for investigating people and place (Elwood & Cope, 2009).

6.3 Data Graphics and Cartography

Otherwise known as ‘content clouds’, word clouds are a form of graphic consisting of either quantitative measures such as word counts and literature length, or more qualitative measures like semantics, emotive themes, and concepts (Cidell, 2010; DePaolo & Wilkinson, 2014). The graphic can be derived of either primary or secondary data sets, including interview transcripts, diary extracts, websites, and blogs, and present a collection of words symbolised by size, colour or weight, representative of the number of times each was referred. They present distributions from within datasets and provide an ‘at-a-glance understanding’ of the most used words, topics, or themes (Cidell, 2010:514).

Word clouds were used in this research to visualise participant’s interpretations, using the questionnaire to collect words describing the participant’s initial perceptions and impressions at each research locations (see Appendix B, question 3). Each participant provided three descriptive words to enable a content analysis and observe a range of responses to measure the mode. Like aggregation, the quantification process linked each questionnaire and corresponding results to specific geographical points via the DCPs, to sort and subsequently map this information for visualisation. Doing so resulted in the production of a map that can present the ideas and concepts from within discourse collected at each cultural heritage site



Figure 26B: ‘Figure 5: Student responses to
 “What is statistics?” at the end of an introductory course’
 (DePaolo & Wilkinson, 2014:04)

As can be interpreted from the Figures 26A and 26B, initially students assumed that statistics were more to do with ‘business’, ‘numbers’, ‘data’ and ‘information’; these being the most frequent words presented in larger font size. However, when the data was recollected at the end of the course, it transpired that students thought statistics were more to do with ‘study’, ‘population’, ‘sample’, and ‘collecting’, with ‘data’ being the most frequently used word, evident by the most predominant word on the graphic. By observing the sizes of the words within each of the word clouds, it is possible to see the range of syntax and pick out initial findings in the analysis. Through a side-by-side visual analysis, Figure 26A appears to show a greater collection of words mentioned by students, suggesting that there were more diverse ideas about statistics. Figure 26B on the other hand contains more predominant words (i.e., eight) with much smaller samples of text, suggesting that students had a better understanding of statistics and used very similar jargon in their responses. This example specifically provides not only an indication of the patterns and trends within the data, but also facilitates a temporal comparison.

As a tool, Cidell (2010) proposes that word clouds can be used as a method for exploratory analysis, associating the spatial quality to a qualitative data set through a qualitative GIS approach. It is possible to use these representations as a method for ‘expressing lived spaces’ as part of a cartographic representation (Wickens Pearce, 2008, cited by Cidell, 2010:515). Figure 27 from Cidell (2010:520) presents an analysis of word frequency from thirteen

metropolitan newspapers. The article regards people's perceptions and opinions of green buildings, from across different regions of America. Here, content clouds are mapped by geographical region, providing a visual comparison across each area. In this example, the most frequently used words across each of the participatory regions were 'energy', 'design' and 'environmental', which link to themes of green building (Cidell, 2010:520). However, on closer inspection, areas like Albuquerque and Portland had a greater focus on institutional semantics, like 'certification', 'city', and 'council', whilst Grand Rapids showed word frequency themes relating to construction, including 'floor', 'forest', 'light', and 'recycled' (Cidell, 2010:520).

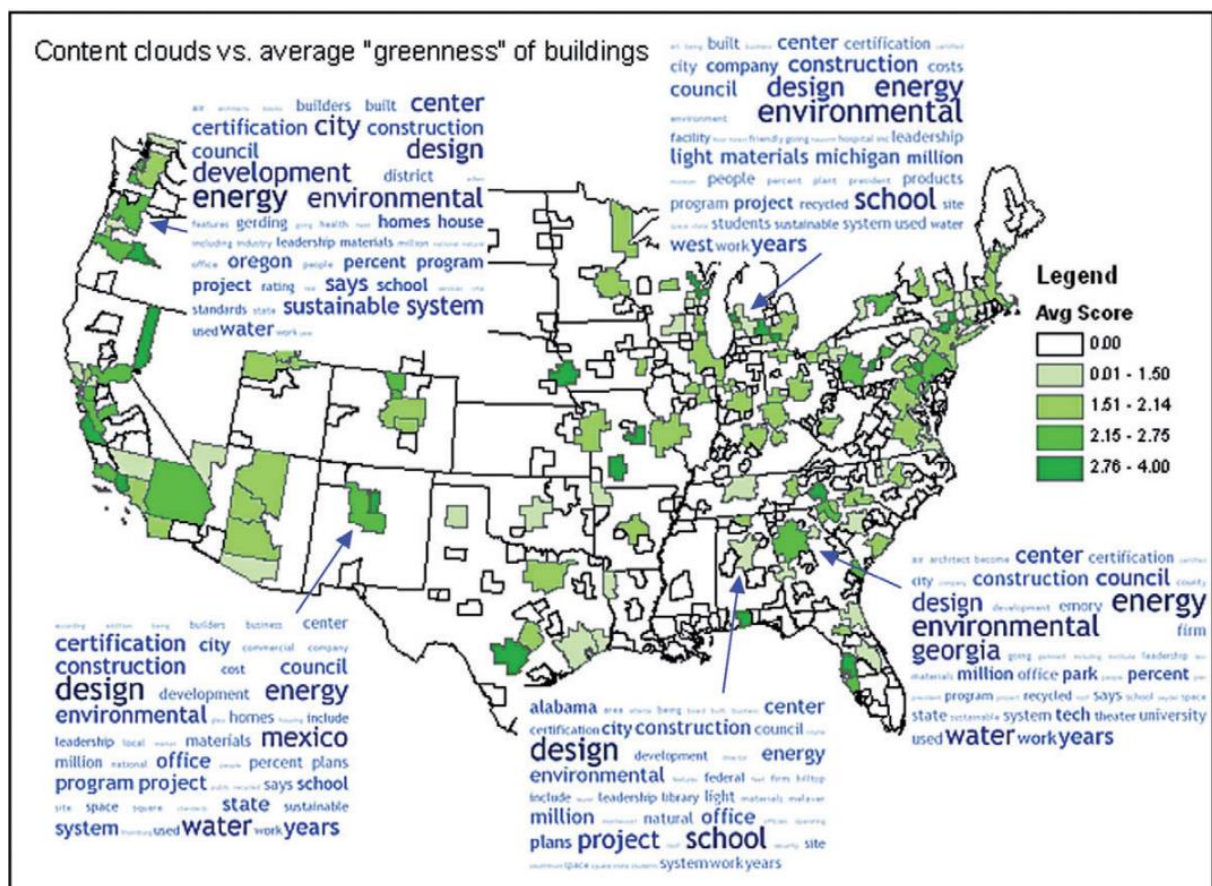


Figure 27: 'Figure 3: Sample content clouds from green building newspaper articles, generated by the author using TagCrowd.com' (Cidell, 2010:520)

In this case, the word clouds are used alongside a choropleth map that shows the average scores of green buildings within a metropolitan area. It provides additional context and information enabling researchers to compare the resulting word clouds to the chosen map layer. However, a limitation is that word clouds generated by either internet sources or software packages are all dependant on the dataset they are representing (Cidell, 2010). Each

unique word cloud may be derived from a different total number of words within the corresponding dataset, meaning each word cloud is independently representative of a specific dataset. The word ‘cloud’ may have been used ten times at either location, but the size of the word is relative to the number of other words in that dataset. The word may be presented on a much smaller scale in one map and appear the biggest and most used, whereas on a greater scale the word may appear the smallest but have the same value. Though size is relative to frequency, the descriptive statistics are a guide when used as part of a comparative approach because they are not an accurate representation of value.

Cidell’s (2010) approach provides evidence that it is possible to integrate a spatial reference to the data and use a similar approach to present opinion and perceptions cartographically. Subsequently, the next section will explore ‘Cartographic Word Clouds’ in content of this thesis, examining the design strategy used to integrate word clouds with a spatial reference for mapping.

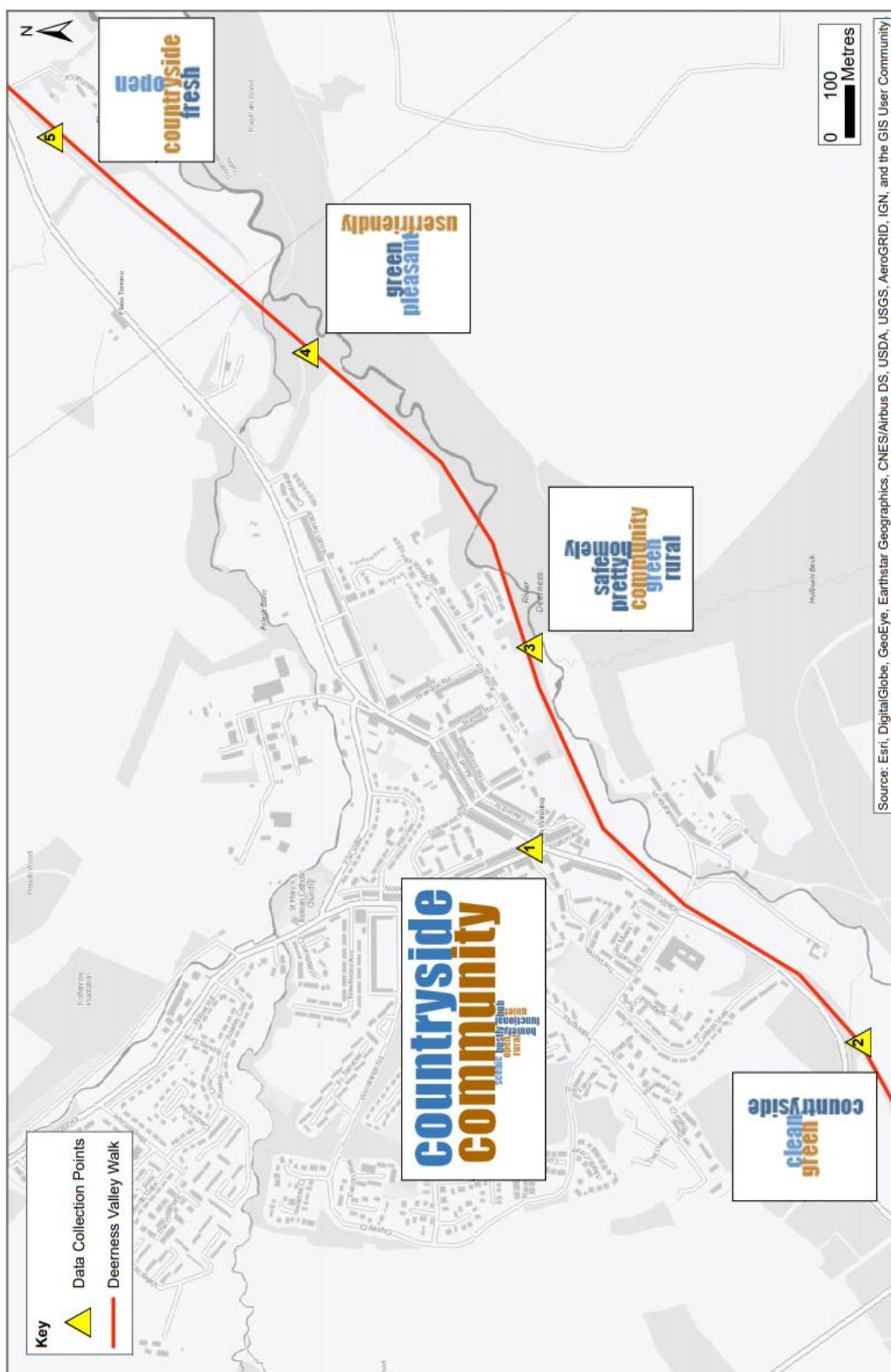
6.3.2 Cartographic Word Clouds

Using similar methods to Cidell (2010) to investigate areas on a much smaller scale, I used the questionnaires to collect key descriptive words and phrases from participants, regarding their first thoughts, feelings, and impressions of the DCP area in which they were stood (see Appendix B):

- 1) Thinking about where you are standing in now, what are your initial thoughts/feelings of the area?

Please provide THREE key terms below:

Categorised the data by DCP, I inputted the data into NVIVO to run a word frequency query, creating a word cloud for the results at each identified location (QSR International, 2017). Each DCP provided the spatial reference to link the data to a specific geographical point, plotting the results in ArcGIS to visualise the qualitative data across each micro-scale area. The following Figures 28A-D are the resulting cartographic representations created for Esh Winning, Stanhope and Durham, using data recorded in the first temporal period of October 2016. I have also created an aggregated version by combining the results for each DCP together, to produce one resulting word cloud that showed the frequency of terms at each research area. This provides another scale for further comparisons across each location.



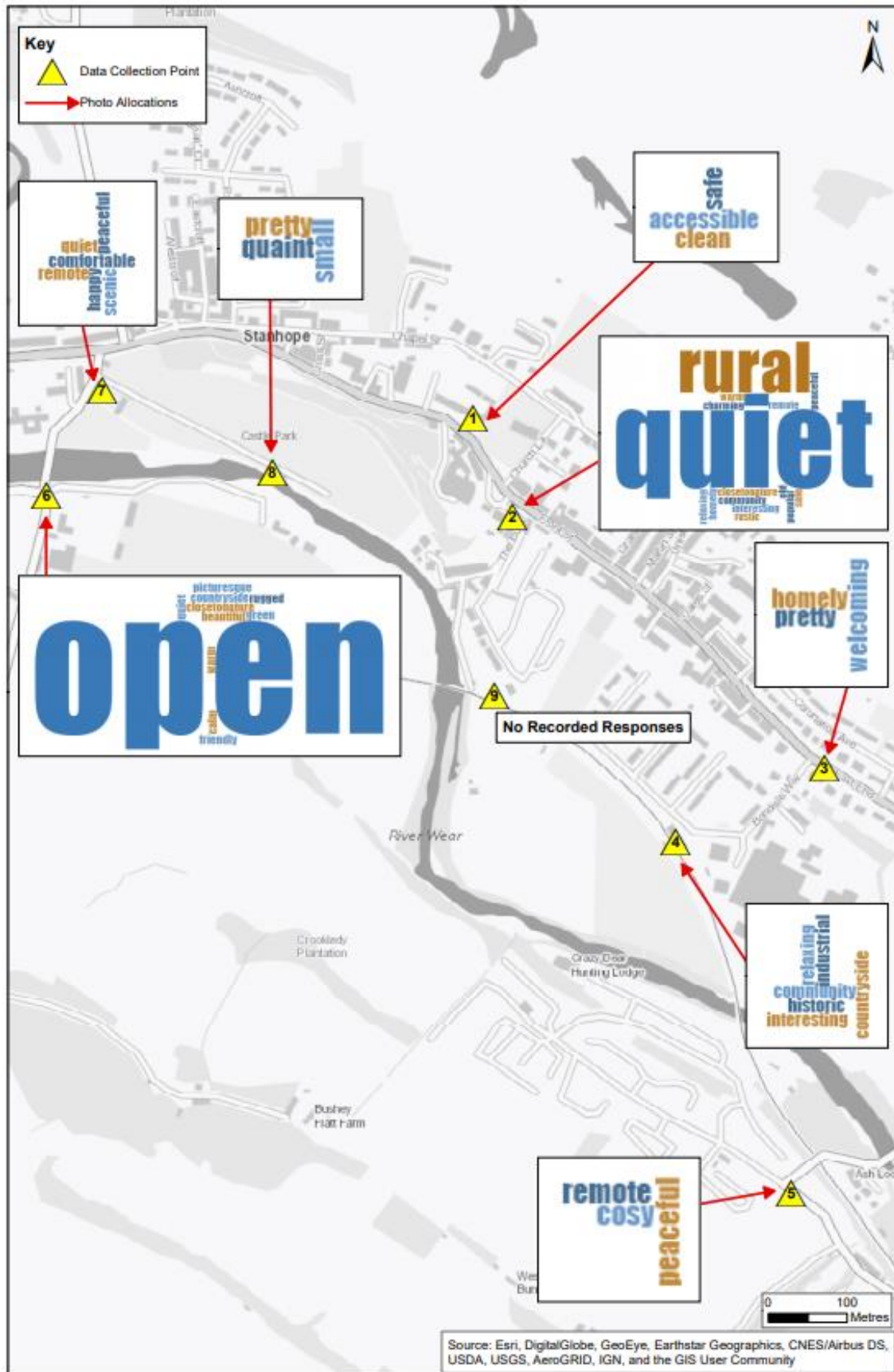
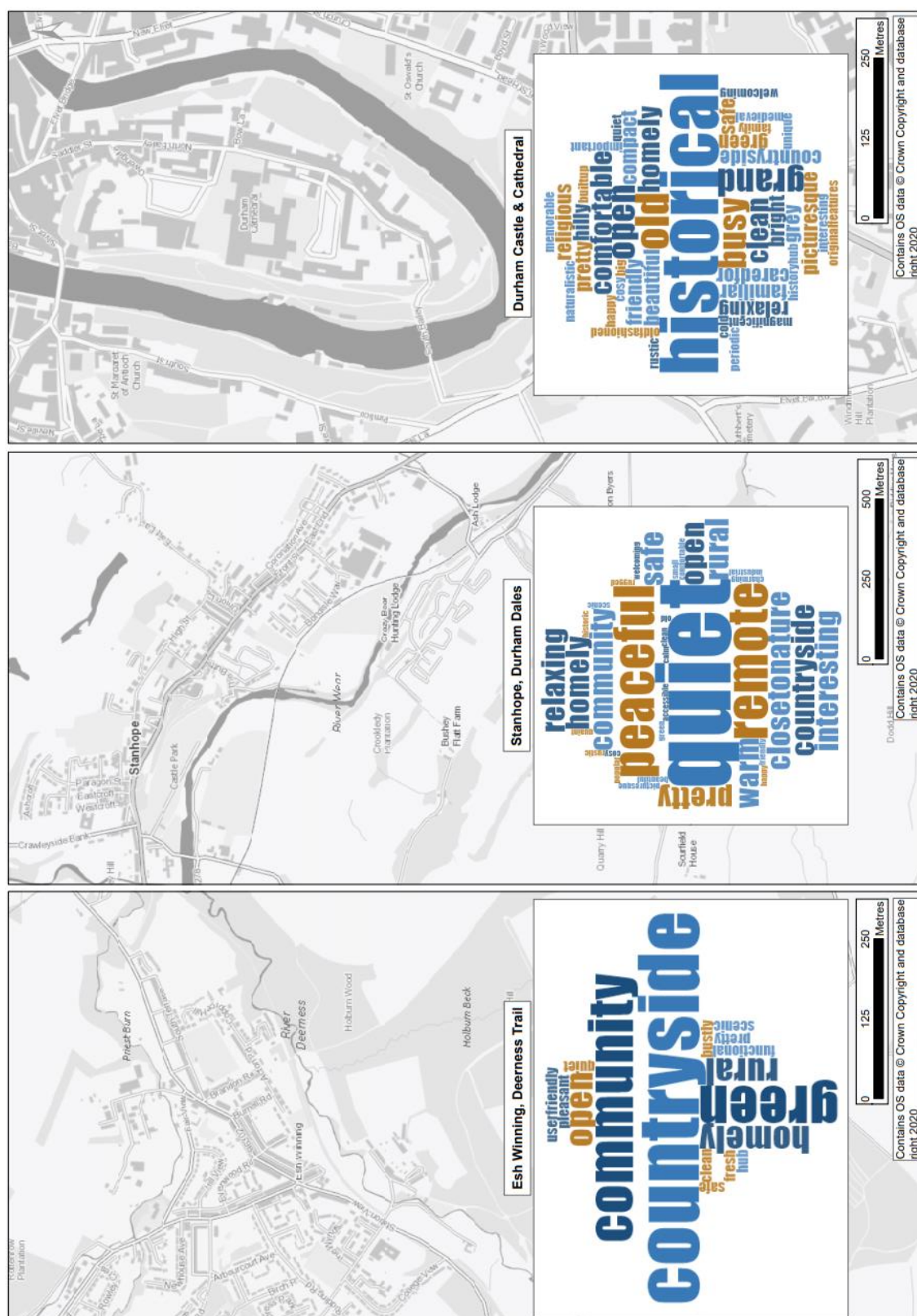


Figure 28B: Cartographic Word Clouds: Stanhope, Durham Dales (October 2016)



Figure 28C: Cartographic Word Clouds: Durham Castle & Cathedral (October 2016)



Notably, the Cartographic Word Clouds follow the rule that the bigger the word the more frequently it was recorded in the collection process. However, the range or variety of words noted and presented in each word cloud does not equal the quantity of responses recorded, i.e., six words noted at one point does not mean six individuals answered. Figure 28A shows that in Esh Winning, DCP1 had two most frequently used words, these being 'countryside' and 'community', whilst DCPs 2-5 appear to have unique individual phrases recorded. Observing Figure 28B, the results for Stanhope show that the most frequently used words were recorded at DCP2 and DCP6, these being 'quiet', 'rural' and 'open', whilst the other recorded phrases at DCPs 1, 3-5, 7-9, appear to have only been noted once. Additionally, Figure 28C for Durham shows the widest range of responses recorded at DCPs 6 and 7. The most frequently referred to words indicated on the map were 'busy', 'historical', 'grand', 'grey' and 'safe'. However, there are a lot of issues and restrictions regarding the use of these maps to present qualitative data. Though they can present participant's responses and opinions about each of the heritage sites, the results themselves are not entirely transparent nor flawless.

The first issue to note regards the total frequency of words collected at each of the research sites, and specifically at each DCP. Looking at Figure 28A, DCPs 2, 4 and 5 only had one participant's response recorded, which I know because there are only three unique phrases indicated in the word cloud. When you compare these word clouds against that of DCP1, it is very difficult to tell the value of the other noted phrases, because the sizing is not consistent. This issue is the same across each of the Figures 28B-C, as well as some phrases being too small to decipher at all. Although users can interpret the most used words at each of the DCPs, to try and make comparison between each DCP is limited and difficult because the size of the word clouds are neither consistent, nor numerically representative. Additionally, there are issues regarding cartographic clutter, whereby the number of responses at each DCP have hindered the ability to see the below basemap. As I have already pointed out, the size of the text is one issue, but this cannot be resolved if there are a vast number of responses allocated to that geographical point. It is a limitation requiring a possible compromise, whether to sacrifice the ability to interpret words which may have been used once or make each word cloud much bigger and restrict access to the underlying base map. In this case, scale is not the issue, but the quantity of results is.

Observing Figure 28D, this map shows the aggregated results for word frequency at each of the research locations. Viewing these cartographic word clouds side by side, it is possible to

visualise the results across each location, pick out the most frequently used words, and compare them against the other research locations. This does not have the same interpretation issues as the representations shown at a much smaller scale but there are still issues regarding quantitative representation. For example, each of the research sites has a different total number of words collected, so the most used word at each site will not have the same value, regardless of their visual appearance. ‘Countryside’, ‘quiet’ and ‘historical’ have not been mentioned the same number of times, though the infographic portrays them at very similar sizes. Users must be mindful not to focus on the actual value of the used word but to follow the visual rule that the bigger the word, the more frequently it was used to describe the location (Cidell, 2010). It is an exploratory technique capable of prompting further investigation and lines of enquiry.

I repeated this process at different times of the year, adding a further temporal quality to the representations. Specifically, the following Figures 29A-C support this mapping method by incorporating time as an attribute to compare different periods of data collection. They are constructed using data collected in Durham at three periods across a year: October 2016⁷², February 2017, and July 2017.

⁷² Figure 30A has been used previously regarding spatial comparisons of Cartographic Word Clouds. It has been provided again for access in the next point of discussion.



Figure 29A: Cartographic Word Clouds: Durham Castle & Cathedral (October 2016)



Figure 29B: Cartographic Word Clouds: Durham Castle & Cathedral (February 2017)

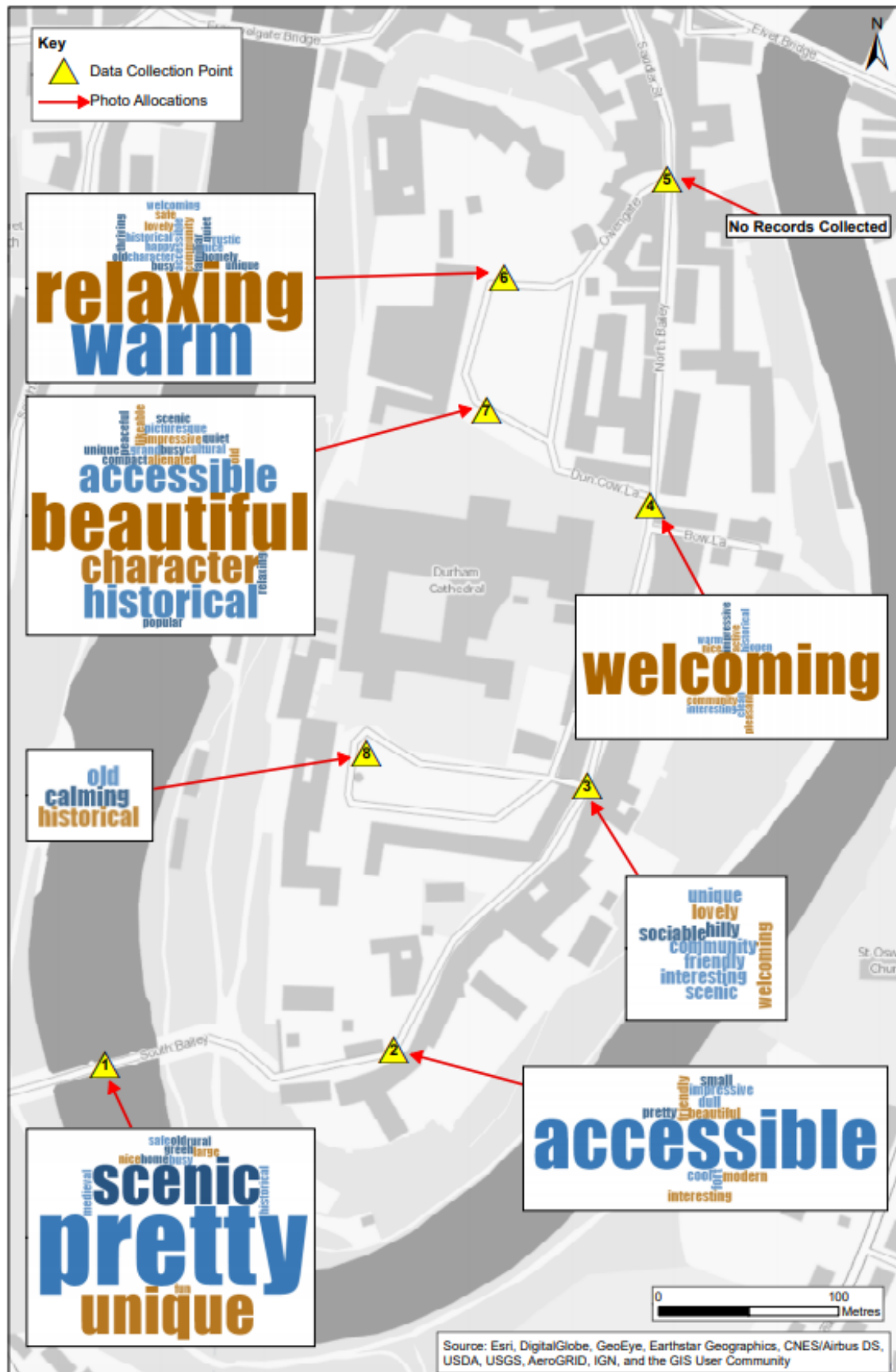


Figure 29C: Cartographic Word Clouds: Durham Castle & Cathedral (June 2017)

Using Figures 29A-C, it is possible to interpret the results for each temporal phase and view the differences in chronological order. These are not presented as one cartographic representation, but as side-by-side or sequential comparisons. Figure 29A presents the data collection in October 2016, with most frequent terms ‘busy’, ‘historical’, ‘grand’, ‘grey’ and ‘safe’ collected at DCPs 6 and 7 yielding a greater range, or variety of results. Figure 29B shows the results for February 2017, presenting similar trends with ‘busy’ and ‘historical’ once again being the most common, alongside ‘community’ and ‘unique’. In this map, DCPs 6 and 7 yet again yield a greater variety of terms provided by participants, with DCPs 1 and 4 also showing similar patterns of response. The third map Figure 29C, shows a different selection of most used terms, with none repeated between the two previous temporal phases, i.e., ‘relaxing’, ‘warm’, ‘welcoming’, ‘pretty’ and ‘accessible’ are the mode responses. As with Figure 29B, DCPs 1, 4, 6 and 7 yet again yielded the greater variety of terms indicated by participants.

In terms of an overall result, October 2016, and February 2017’s data collection indicated two key phrases of consistent use by participants, whilst June 2017 showed a change in the descriptive terms provided. For example, ‘busy’, ‘historical’, ‘community’, ‘unique’, ‘grand’, ‘grey’ and ‘safe’ seem to refer more to the physical description of the surroundings at DCPs 1, 4, 6 and 7, whilst June 2017 provided more descriptive terms relating to the area’s atmosphere and personal feelings. The results for October 2016, February 2017 and June 2017 may also be related to surrounding atmosphere and personal feelings, suggesting potential ambiguity regarding the perceived results. In this case, the data collection method required further tailoring to collect descriptive words about specific attributes, such as the physical environment, atmosphere, and personal feelings. This would reduce issues of inexactness by presenting each collection of words in context to the described theme. The differences between the collated responses, however, could also be a result of the different time periods themselves with June being the warmer summer months. In terms of location, DCPs 6 and 7 are areas of higher footfall and provide further opportunity to engage with individuals at those specific points. They are also situated by the main attractions and landmarks on the Durham peninsula.

However, this map has similar limitations to the previous examples whereby the perceived connections and results are dependent on users fully understanding the purpose of the map. Users can only interpret the results based the word cloud symbology and interpretation rule that the bigger the word the more times it was recorded in the data collection process.

Additionally, like the previous examples, the word cloud plots do not sit on top of the geographic reference indicated by the DCP. I specifically chose not to do this so that users could access the underlying basemap, to prompt considerations regarding why those terms were used. It allows the user to note the word and be able to look closely at each specific site and interpret the potential link to the people's perceptions of place. However, there is still a lack of information regarding external influences and factors. Specifically, it is hard to tell what the weather was like, how busy the area was, and whether there were any organised tourist attractions and events happening. Each of these could have had an effect not only on the number of people in an area, but also the atmosphere at each point, consequently persuading people's perceptions, and interpretations of place. A lack of entertainment and activity may persuade more negative/neutral thoughts about a place, similarly that sunshine tends to promote more positives response. Furthermore, there is no referral to the external context of these maps as they are designed specifically to visualise people's relationships with place based on each cultural heritage setting. These maps must be used in context to the relevant research, to fully understand the data visualisation.

Furthermore, this method is restricted by spatial scale, whereby the number of words under analysis will have a resounding effect on the resulting data visualisation. Arguably, the aggregated datasets at each research location produced more meaningful results due to there being a higher quantity of words listed, as the DCP-level data contained several issues and restrictions that hindered the communication of results. The relativity and dependency of each word cloud graphic means that the descriptive statistics associated can only be used as a guide, to pinpoint potential trends and patterns from within qualitative data sets and discourse. Effective statistical graphics are therefore only achievable if they are communicated with 'clarity, precision and efficiency', to meet their aim of revealing data and 'complex' ideas (Tufte, 1983:13-15). Whilst the above examples do show qualitative representations of data in a more creative form, they are less scientifically objective than other charts, such as scatter plots, dot plots or line graphs. Their credibility is associated to the level of familiarity and knowledge a person must use to interpret such representations, as well as the experience to construct and formulate effective formats (DiSessa & Sheridan, 2000).

On the other hand, these maps are primarily descriptive, supplementary data visualisations, designed to observe the relationships and connections between people's opinions and their surroundings. They are an 'at-a-glance' source of information that do not require the provision of numerical values and statistic (Cidell, 2010:514). The maps do serve their

purpose to present qualitative data through cartographic representation making use of a more creative, qualitative GIS approach (Knowles, *et al.* 2015). It is possible to make both a temporal and spatial analyses of the results, based on the scale and aggregation of the data collection and manipulation. Consequently, these cartographic word clouds can produce new data, specifically a new type of qualitative spatial data (Jung, 2009; Cope & Elwood, 2009; Cidell, 2010). They provide an indication of patterns and trends as a starting point for investigation, and are not a replacement for more detailed, more careful analysis (DePaolo & Wilkinson, 2014). They provide the initial motivation to begin looking more closely at datasets, but not the grounds to start querying various details and context (DePaolo & Wilkinson, 2014).

6.4 Qualitative Cartography

Termed ‘qualitative cartography’, the following maps are designed as a form of relational chart type, to view potential correlations and connections within data sets, specifically derived from an analysis of qualitative information (Kirk, 2016). The ‘qualitative’ refers to the type of data collected using quantifiable methodological means; ‘cartography’ refers more literally to the act of designing and creating maps, to present the qualitative material. The maps themselves are derived using similar motives to Cartographic Word Clouds, however they have an additional purpose to visualise qualitative data and the links between people and place (Kirk, 2016). Their aim is to function as an effective data visualisation tool through more cartographic forms of representation. Specifically, the section begins by outlining and justifying the use of Likert scales in the data collection process and how this question type framed the design of a new type of map. Associating the spatial quality is then investigated through an examination of Cooper & Gregory (2011), who have devised a series of maps that can present qualitative detail collated from a discourse analysis of secondary data sources (i.e., diary entries). It acknowledges the strengths and limitations of their work and considers these issues in the design of the Likert Maps. For example, I critique Cooper & Gregory’s (2011) application of a spatial overlay for background context and how better to represent the story coming from within the data sets (Yau, 2011; Kirk, 2016). Consequently, the section investigates designing a colour symbology that has the capacity to represent qualitative data and reveal the cartographic narrative. Having successfully done so, I have categorised and collated people’s perceptions of landscape, to plot this information geographically. I have created a new form of data visualisation by combining the properties of relational chart types with those of spatial to visualise relationships between people and place.

6.4.1 Quantifying the Qualitative and Colour Representation

Questionnaires were a key method of data collection used to incorporate a series of open and closed question types⁷³. Through an exploratory questionnaire, I used several question formats to collect a variety of quantitative and qualitative information to collect people's perceptions at cultural heritage sites (Parfitt, 2005; Remenyi, *et al.* 2011). Specifically, I included Likert scales to collect qualitative information in a more quantified manner to process and subsequently transform it into cartographic representations.

Likert Scales

Likert scales were included because of their ability to provide a measure of people's perceptions, opinions, and attitudes, to specific topics and ideas (Hartley, 2014). Each participant was asked to acknowledge a statement relating to a specific theme (i.e., landscape appreciation) and consider to what extent they agreed/disagreed with the phrase, indicating their response on a numerical scale. Each response was then readily measured and recorded in numerical form using the provided scale, thus readily quantified, and sorted into accessible categories for calculating an average value (Harpe, 2015). The resulting benefit of this technique is the ability to manipulate these generalisations through various mapping processes, to visualise evidence of specific landscape concepts rather than having to filter through various transcripts and description. However, a limitation of the Likert scales relates to the aggregation process and representative values. Esh Winning only had nine participants who took part in the survey and Durham twenty-eight, meaning that by generalising the results and calculating an average each research location would appear to have the sample population size.

They were designed to collect perceptions that provided evidence of five sense of place components⁷⁴; attachment to place, social relations, adaptability of use, landscape appreciation, and landscape satisfaction. I also asked two direct questions about awareness of heritage spaces and the importance of preserving these spaces for sustainable appreciation. The purpose of doing so regarded my engagement with Wylie (2007) and the conceptualisation⁷⁵ that landscape has a subjective, intangible veil of thoughts, beliefs and perceptions woven upon and within the fabric of space. It is this metaphorical layer that I have

⁷³ See Chapter 3.0, section 3.3.3 Questionnaires

⁷⁴ See Chapter 2.0, section 2.4.2 The Landscape Veil.

⁷⁵ See Chapter 2.0, section 2.4 Experiencing Heritage Landscape

attempted to investigate and record evidence of, using cultural heritage landscapes as the focus due to their associated value, cultural significance, and historical importance (Wylie 2007; Vecco, 2010). Being a multifaceted concept, sense of place was the identified concept because it is a term used to describe and understand the relationships that people develop with place. These relationships are made up of people's experiences, meanings, degrees of sentiment, and values that they as individuals have associated to specific environments and places (Shamsuddin & Ujang, 2008; Soini, *et al.* 2012). The resulting bonds are therefore key pieces of evidence that can assist in understanding how individuals interpret various landscapes and places, exploring the symbols and points of reference that are used to link various details to personal representations of landscape. To reiterate my observations from Chapter 2.0, the landscape veil has a significant role in understanding how individuals develop interpretations of place, how landscape is represented through aesthetic qualities, various physical features, and the symbols that are embedded within the metaphorical and physical layers of landscape (Wylie, 2007; Howard, 2011; Soini, *et al.* 2012; Brown, *et al.* 2015). Cultural heritage sites provided the ideal context to observe these qualities, because they exist as complex spaces of socio-cultural representation, symbolic constructions, and historical significance (Yang, *et al.* 2016).

The questions used to provide a measure of perception were constructed using a five-point scale whereby participants ranked a statement from one to five. I kept a mid-point of 3 to represent more neutral responses rather than forcing respondents to consider the statement and give a more specific response (Hartley, 2014; Harpe, 2015). It ensured that responses were still collected, regardless of whether participants felt either negatively or positively towards any of the statements. More specifically, instead of asking participants for direct answers of 'yes' or 'no', the Likert scales provided a spectrum for individuals to associate their opinions and perceptions to, participants are more likely to be comfortable with providing a more detailed answer, rather than the direct yes-no binary (Gosavi, 2015). To provide a quick recap, the following example was taken from Appendix B, to indicate the format of the Likert scales:

Qu) To what extent do you agree with the following statements?

Please indicate just ONE column of agreement per statement:

Attachment to Place					
a) I know Durham really well.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5

Earlier discussions⁷⁶ found that there were issues with this method, however I have tried to resolve these in my approach. For example, where statements were not applicable to the participant, the zero provided an opt-out or ‘not applicable’ response that were subsequently excluded from the data analysis, being the calculation of a Likert average. Additionally, some statements were purposely worded negatively to ensure full engagement and understanding by participants, whereby the numerical values consistently correlated to the scale of strongly disagree to strongly agree, regardless of the phrase⁷⁷.

Associating a Spatial Attribute

The following figure has been taken from Cooper & Gregory (2011:103), who provide an example of how to utilise the spatial characteristic of data. It uses detail derived from the discourse analysis of a diary, specifically, Samuel Taylor Coleridge’s journey across the English Lake District. Qualitative description was highlighted, coded, and transcribed regarding any notion of moods, meanings, and emotional responses to the surrounding landscape, to develop more ‘exploratory’ types of map (Cooper & Gregory, 2011:94). The result was a ‘mood map of Coleridge’s tour’. Cooper and Gregory (2011:103), however, note that these visual representations are ‘static [and in] a sense of fixity’, as these representations do not present any notion of movement made by Coleridge when writing his accounts of the Lake District. The map does present evidence of how to map the feelings/emotions recorded in the diary entry of Coleridge, pinpointed, and plotted in correspondence to the areas they were mentioned in. For the Likert Maps, the DCPs are geographical references where the methods were carried out, consequently being the points for data to be plotted and detail associated to.

⁷⁶ See Chapter 3.0, section 3.3.3 Questionnaires

⁷⁷ See Hartley (2014) regarding Likert scale considerations.

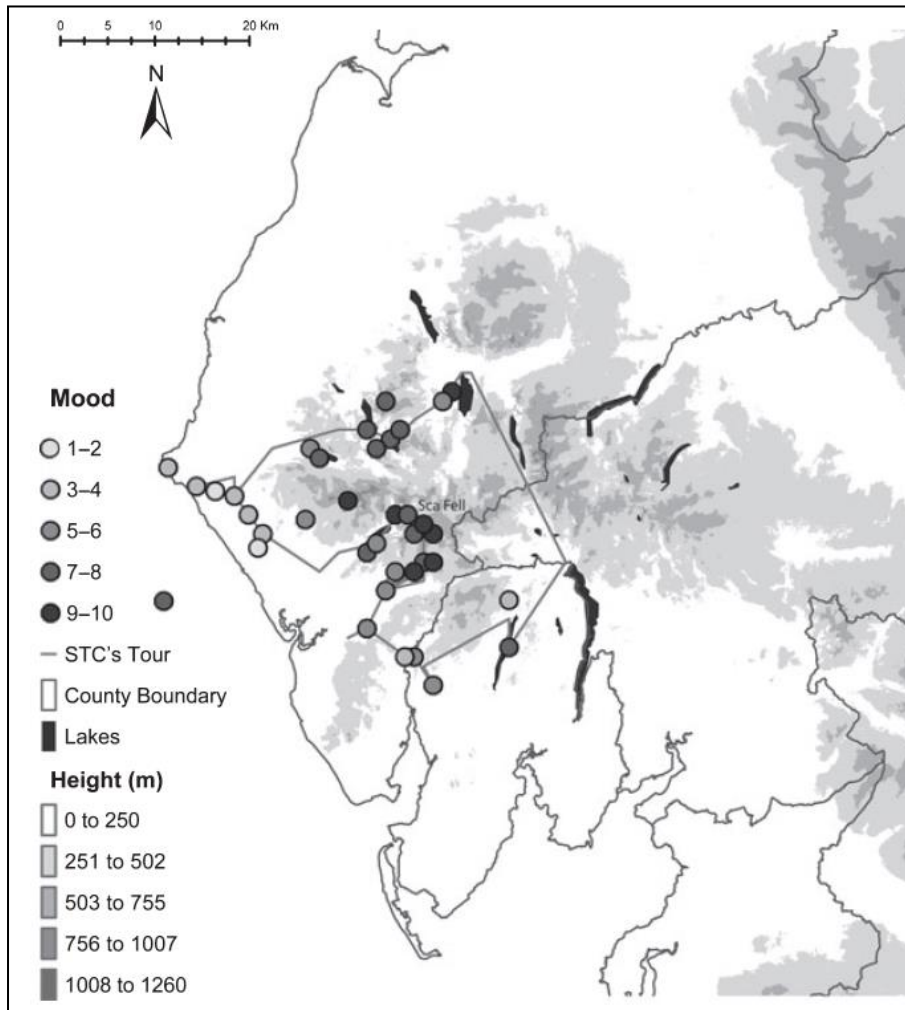


Figure 30: 'Mood Map for Coleridge's Tour'

(Cooper & Gregory, 2011:103)

Regarding Figure 30, the noted feelings/emotions were categorised under one of the mood series highlighted in the map key. In this case, there are a cluster of mood points around the Scafell region with scores of '7-8' and '9-10', though there is little explanation regarding what this numerical scale means. There appears to be darker mood points located around the main urban areas, specifically Scafell, with lighter mood points located further towards the coastline. Though Cooper & Gregory (2011) have used equal intervals in their map series and an allocated colour ramp, there is the additional issue regarding which words fit under which numerical category. Based on my own initial interpretation, I would assume that the darker the points the stronger the noted emotions/moods were felt by the author of the diary; the lighter the colour symbolisation may suggest feelings which were less strongly felt. Cooper & Gregory (2011) do exemplify their meanings in-text, but it is not clear when observing the map and the corresponding key. As a result, this map cannot be effectively understood out of

context of the research. Additional supplementary material and context is required to interpret the map and fulfil its purpose to present qualitative detail derived from discourse analysis.

Harpe (2015:839) suggests that whilst Likert scales are ideal for facilitating aggregated data, to ensure they are viable from a more ‘statistical standpoint’ the distance between each series of classification needs to be equal. This would provide an interval level of measurement, i.e., the distance between agree and strongly agree is only one, whilst the distance between strongly disagree and neutral is three. Though these figures are recognised as ordinal levels of data, researchers still fall into the habit of classing these as equal interval (Blaikie, 2003; Jamieson, 2004) being a limitation with little that can be done to alter the scales. The value, either zero through to five, is not representative of an actual quantity or value and are used primarily as a numerical representation for each word/phrase. Additionally, these intervals need to be specified, to ensure that the classifications do not overlap, and the responses fit under one category, i.e., if researchers were to use 1-2, 2-3, a response of ‘2’ would fall into two of the response categories. However, there are few tools or statistical models to help researchers interpret and validate their findings, with questions surrounding the legitimacy of results derived from Likert scales (Jamieson, 2004; Gosavi, 2015). If researchers want to incorporate statistical analysis, they should instead refer to the median or mode, using descriptive strategies to explain their findings because the values are representative of verbal statements/phrases (Blaikie, 2003).

Likert Symbology

Consider hypothetically that there were ten responses collected in Durham at DCP1, regarding the statement, ‘I know Durham really well’; i.e., scores of 1, 2, 3, 3, 4, 4, 4, 5, 5, 5. The average would be the total of those scores, divided by the number of responses; $36 / 10$, with an answer of 3.6. Using the Likert scale, this value associates to a corresponding class, to determine the average level of agreement to the statement. However, because there is a decimal place involved, this requires predefining the numerical values of each class, to provide the specific interval boundaries for each level of response. For example:

N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1.00 – 1.99	2.00 – 2.99	3.00 – 3.99	4.00 – 4.99	5.00

Table 4: Likert Scale Classifications

Table 4 for is a small-scale example where larger quantities of responses can produce average values calculated with more than one decimal place. To resolve this, the values were rounded off to two decimal places to provide a concise numerical value to ensure an accurate colour representation. The numbers were able to sit within their defined classes for associating the colour symbology. The zero value for ‘not applicable’ was not included in the calculation of an average, to ensure the value was representative of those who did provide a response. Furthermore, the ‘not applicable’ class is set with a series label of ‘0’ as there is no information to include, the ‘strongly agree’ class is set at a value of ‘5’ because participants are not able to provide nor produce a score higher than this.

Using these predefined groupings, graduated colours were then applied to each specific class to provide a distinct colour representation between each category of response (Monmonier, 1996):

N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1.00 – 1.99	2.00 – 2.99	3.00 – 3.99	4.00 – 4.99	5

Table 5: An Example of Likert Colour Symbology

The example provided in Table 5 presents each classification with a unique, clear, and easy to interpret colour symbolisation. The information is easy to access, and each class can be quickly differentiated and identified. The above scale a) enables for efficient use, whereby the user can identify the variables from the map within the key correctly, b) can show change across the map regarding magnitude, and c) enables a visual comparison of quantitative data within the map itself (Robinson, *et al.* 1995). However, the data collected for this research project was qualitative and is unable to associate a ‘magnitude message’ (Robinson, *et al.* 1995:381). Table 5 incorporates this attribute in the Likert colour symbology, so is unsuitable for the data representation. The alterations are noted in the following sub-section.

To summarise the above, Likert scales have their limitations, but they also have a great deal of use and potential. The numerical representation of emotions and the ability of participants to associate their feelings to specific numerical categories is a difficult factor to overcome, however consistency is key ensure usability (Hartley, 2014; Harpe, 2015). The use of colour classifications and specific shades/hues to symbolise the data is always going to be a

contested topic. I need to make sure that the colours serve their purpose, represent information clearly, and do not cause further hindrance nor confusion in the communication of information. Taking the critiques and ideas of colour association from Cooper & Gregory (2011), the next section explores the development of a new type of cartographic representation, achieved by associating numerical values to specific colours through a devised colour symbology ramp to represent the information visually and effectively (Monmonier, 1996; Robinson, *et al.* 1995; Cooper & Gregory 2011; Kovesi, 2015). These have been titled ‘Likert Maps’.

6.4.2 Likert Maps

The aim of the Likert scales is to function as key data collection techniques for quantifying qualitative detail and calculating a numerical figure representative of average responses. Once calculated, these figures were processed through GIS to map the responses recorded for each series of statements by concept, representing various trends and correlations through an effective symbology. Using Durham as an example, data collected around the peninsula area would provide a range of information regarding individuals’ perceptions and landscape interpretations. Referring to the statement from the previous Likert scale example, ‘I know Durham really well’, participants asked down near the river on Prebends Bridge (DCP1) would presumably provide an average response that strongly disagrees with this statement. Individuals asked outside the main student accommodation blocks may have resulted in an average response rate of strongly agree. Here, it is possible to suggest reasons for these results, such as participants down at Prebends Bridge consisting of mostly visitors, whilst those outside accommodation block may be predominantly residents living locally/temporarily (i.e., university students). This mapping process provides an alternative method for understanding the interactions and behaviours within each location, by observing the geographical distribution of opinions across each research site.

Referring to the discussion of Monmonier (1996) and Cooper & Gregory (2011) earlier, the following table presents a developed and improved Likert colour symbology scale used in the creation of the Likert Maps. The decimal points have been removed as there was no need for participants to access to this level of detail.

N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5

Table 6: An Improved Likert Colour Symbology⁷⁸

Table 6 was designed using equal intervals of classification (Harpe, 2015), using a scale of colour hue to visually represent participant's responses to each Likert statement. Being qualitative data, the colour symbology needed to represent different opinions between each point and indicated average response (Robinson, *et al.* 1995), it did not need to communicate magnitude, intensity, or density (Monmonier, 1996). Using one specific colour and associated hues reduces the risk of assumption, whilst the colour symbolisation implies that the darker the colour, the more people agreed with that specific statement. The colour blue in Table 6, is the only consistent, universally used colour convention recognised by mappers, cartographers, and other professional data visualisation users (Robinson, *et al.* 1995). It was an ideal choice as it communicates neither a positive nor negative assumption of the data it is symbolising.

Choosing the colours required additional testing to make sure that the hues identified were clear and easily differentiated, without being hindered by the rest of the cartographic representation. However, it is impossible to design a colour scale suitable for all data visualisations and representations (Kovesi, 2015). The Likert scales were put into the legend with each numerical value corresponding to colour hues and annotated with their meaning (Robinson, *et al.* 1995). It enabled users to understand the significance of various trends in relation to spatial context, resulting in a spatial analysis of qualitative and quantitative data through cartographic representation (Robinson, *et al.* 1995). The results are observed below:

⁷⁸ These colour symbology tables are primarily a visual guide for outlining this example; it is not a direct replica of the colour ramp used in the construction of the data visualisation methods.

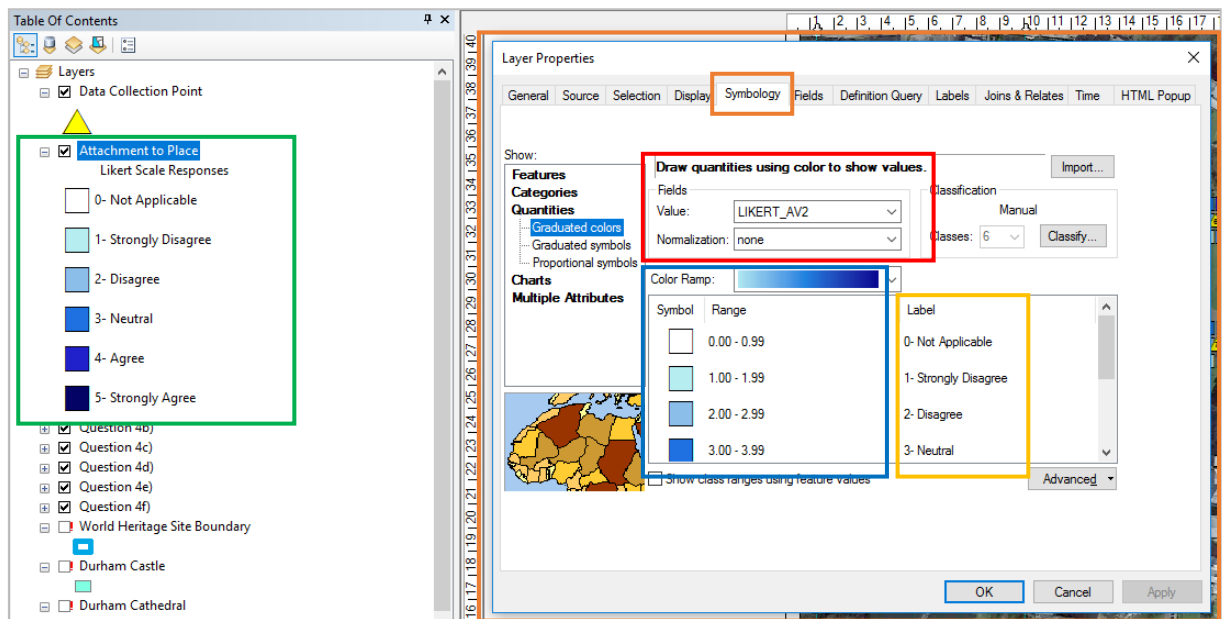


Figure 31: The Application of the Likert Colour Symbolology in ArcMap

Key

- Data File
- Layer Properties & Symbology
- Symbolised Values- Likert Average
- Colour Hue Allocation
- Identified Map Legend Labels

Figures 32A-F present information about people's perception of place, specifically, interpretations of sites across Durham peninsula, which vary in terms of heritage, historic and symbolic association. Each map is designed to enable a spatial comparison between DCP, using the colour symbology to determine the mean response to a series of statements associated to a theme, i.e., attachment to place. Each square represents one of the statements put to participants and categorised under an identified theme, with a 'survey question symbology' provided for further clarification. The information presented is from the October 2016 data collection period.

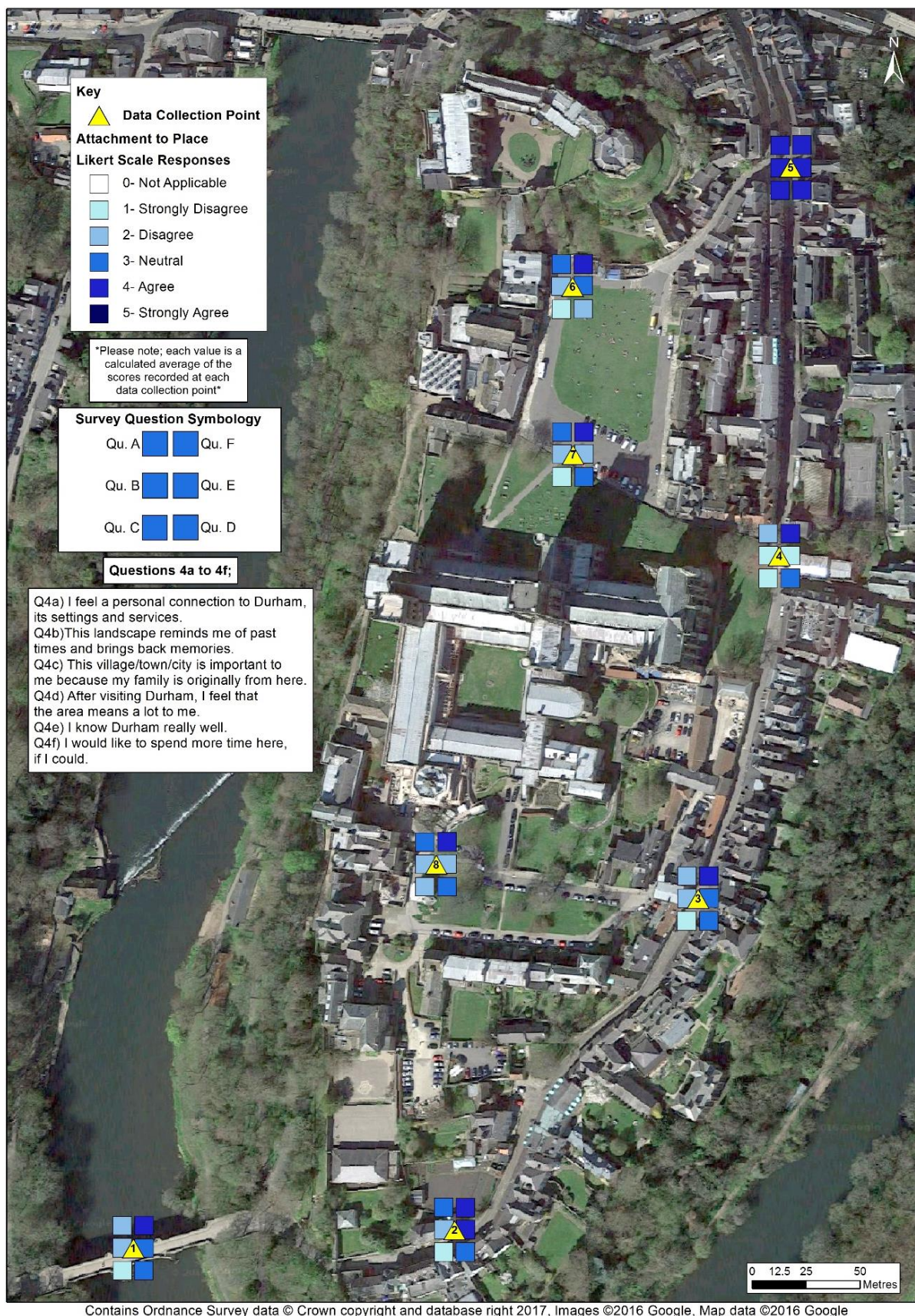


Figure 32A: Qualitative GIS & Likert Maps: Visualising ‘Attachment to Place’ on Durham Peninsula, County Durham (October 2016)

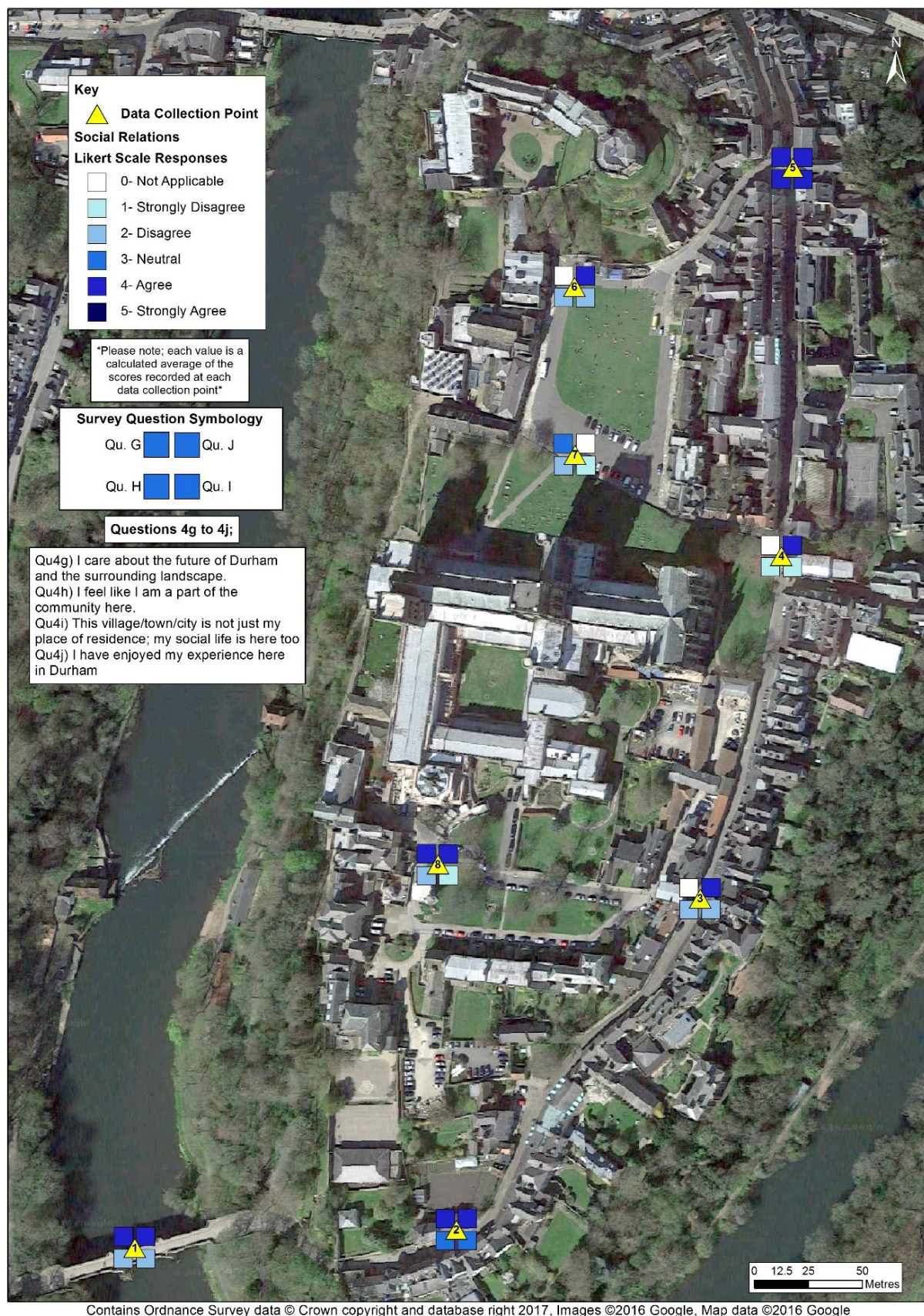


Figure 32B: Qualitative GIS & Likert Maps: Visualising ‘Social Relations’ on Durham Peninsula, County Durham (October 2016)

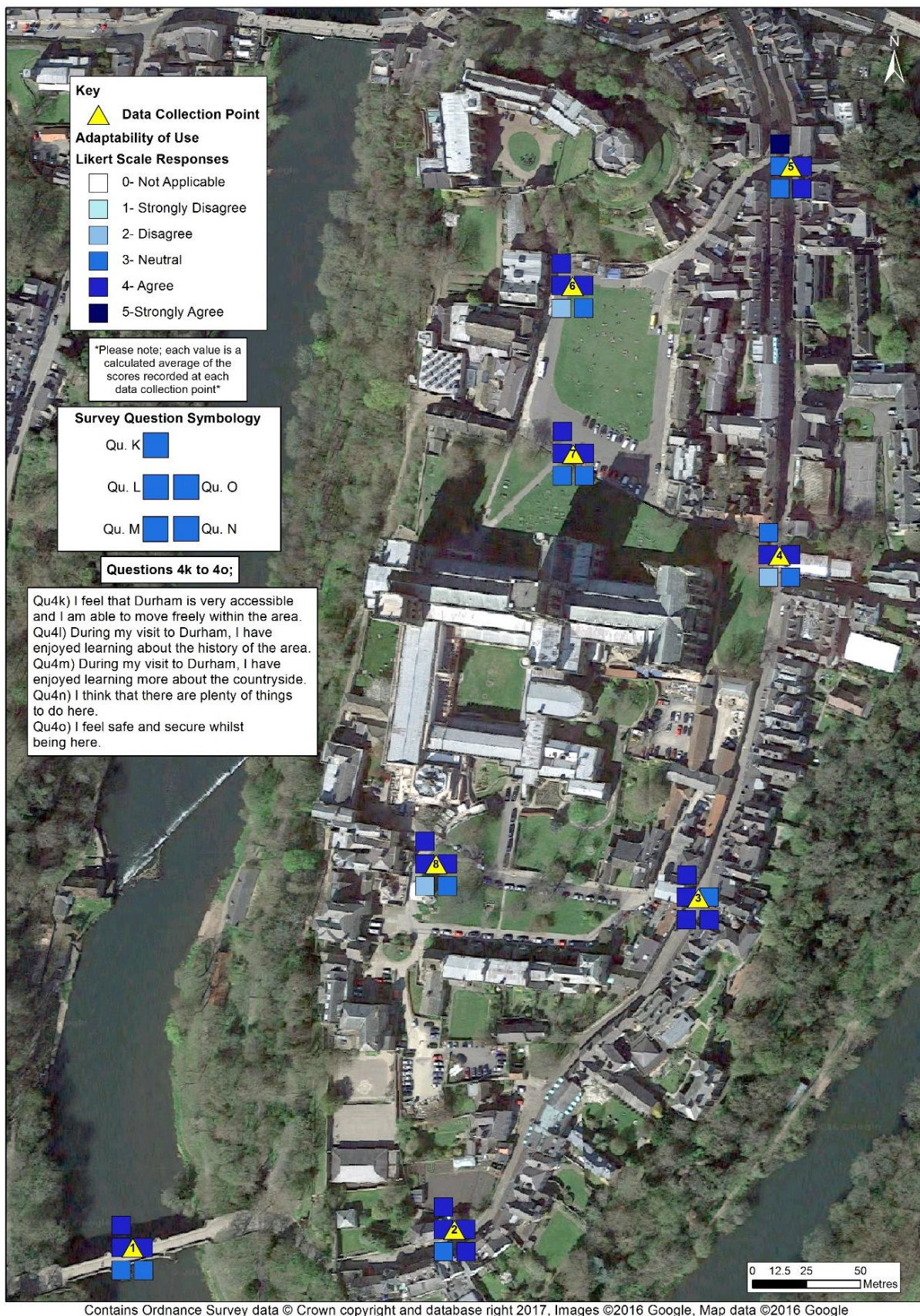


Figure 32C: Qualitative GIS & Likert Maps: Visualising ‘Adaptability of Use’ on Durham Peninsula, County Durham (October 2016)

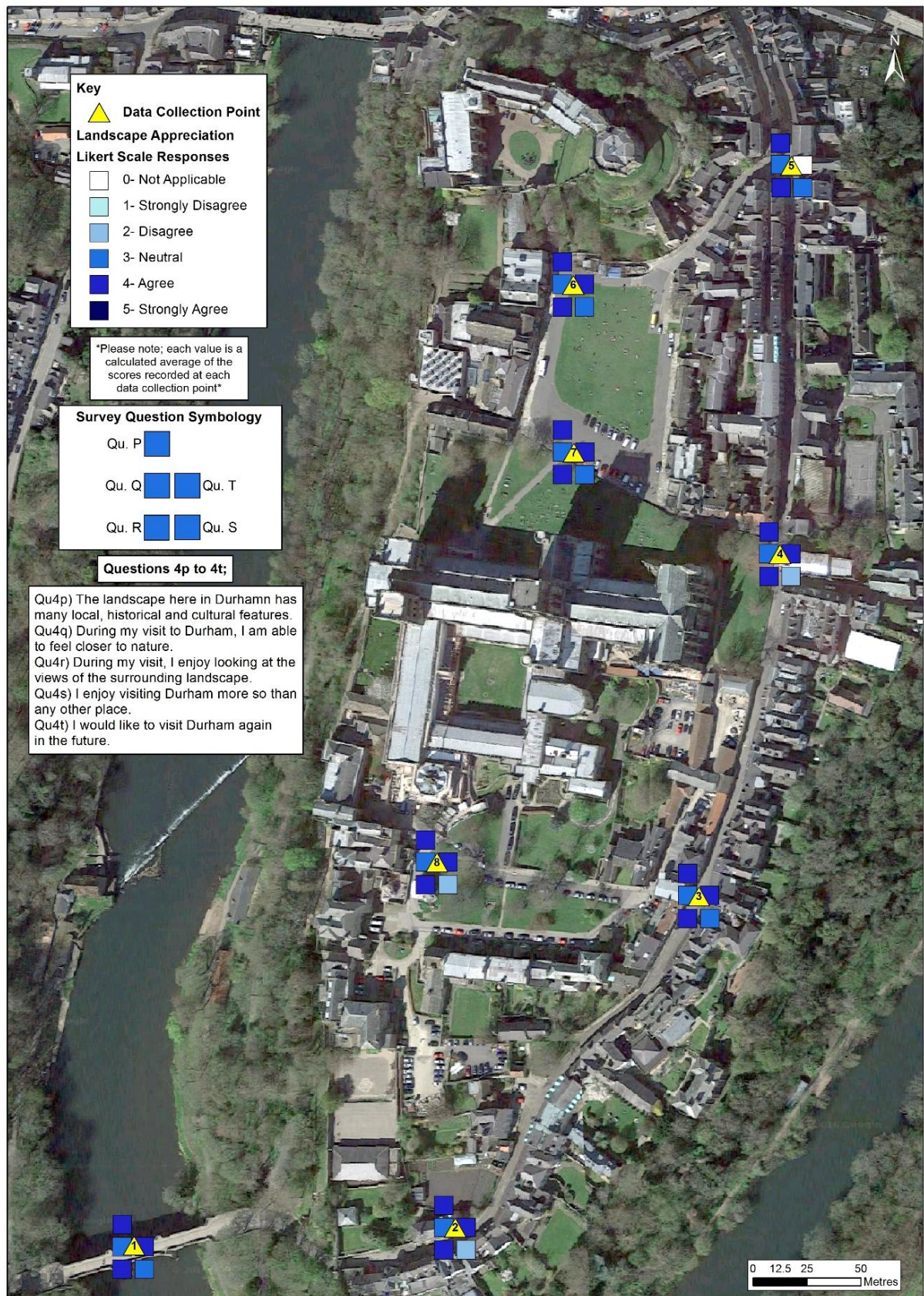


Figure 32D: Qualitative GIS & Likert Maps: Visualising ‘Landscape Appreciation’ on Durham Peninsula, County Durham (October 2016)

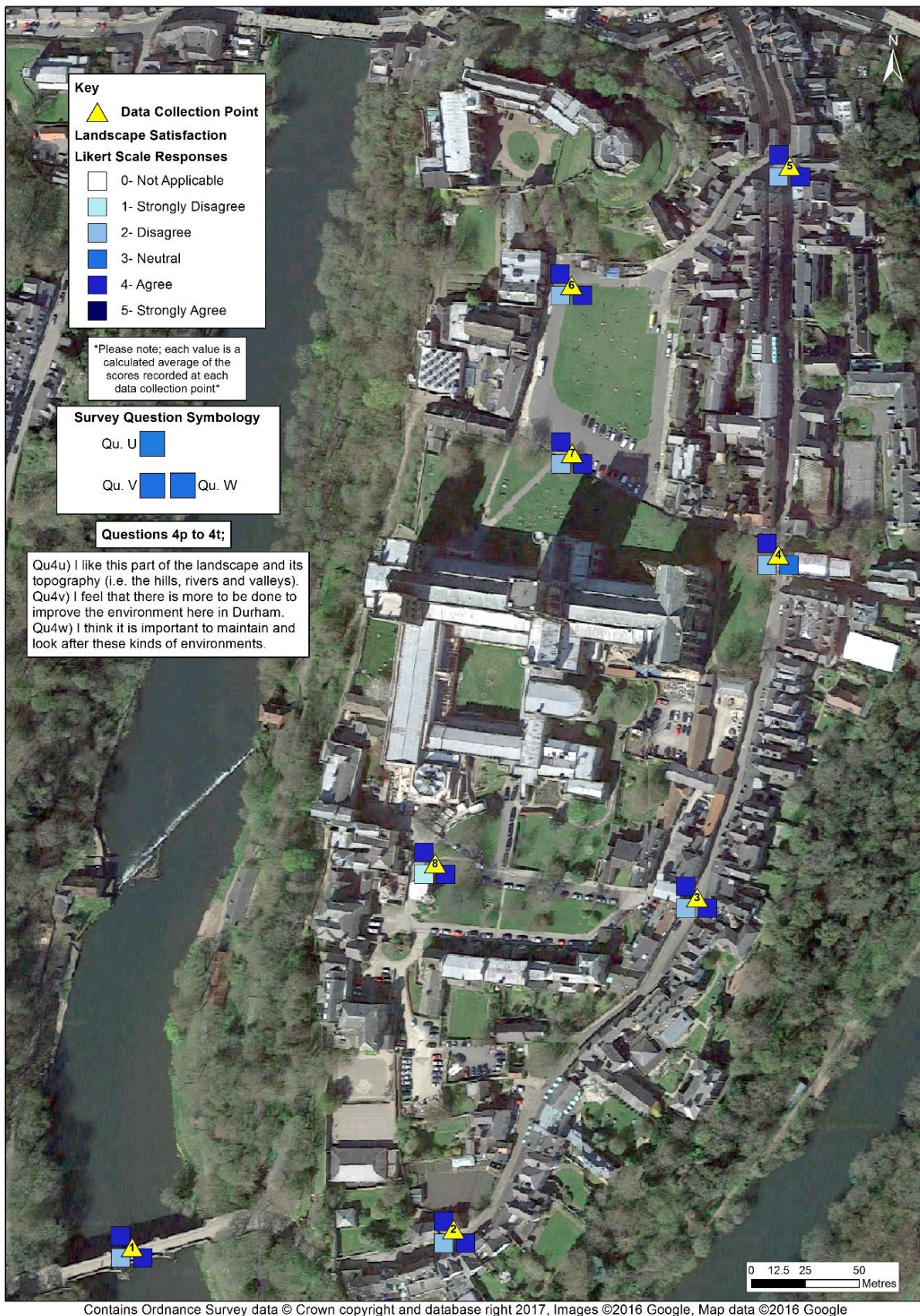


Figure 32E: Qualitative GIS & Likert Maps: Visualising ‘Landscape Satisfaction’ on Durham Peninsula, County Durham (October 2016)

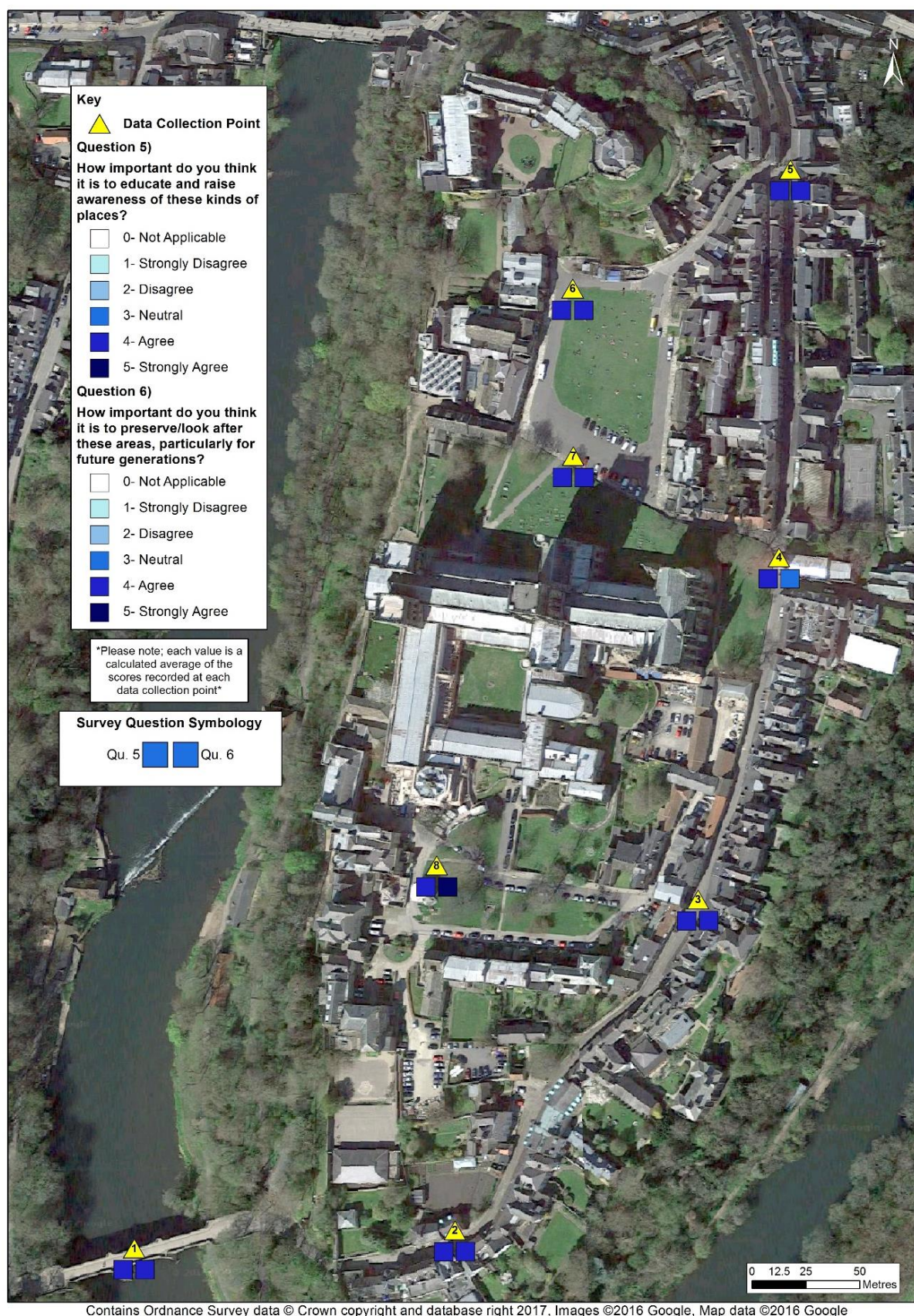


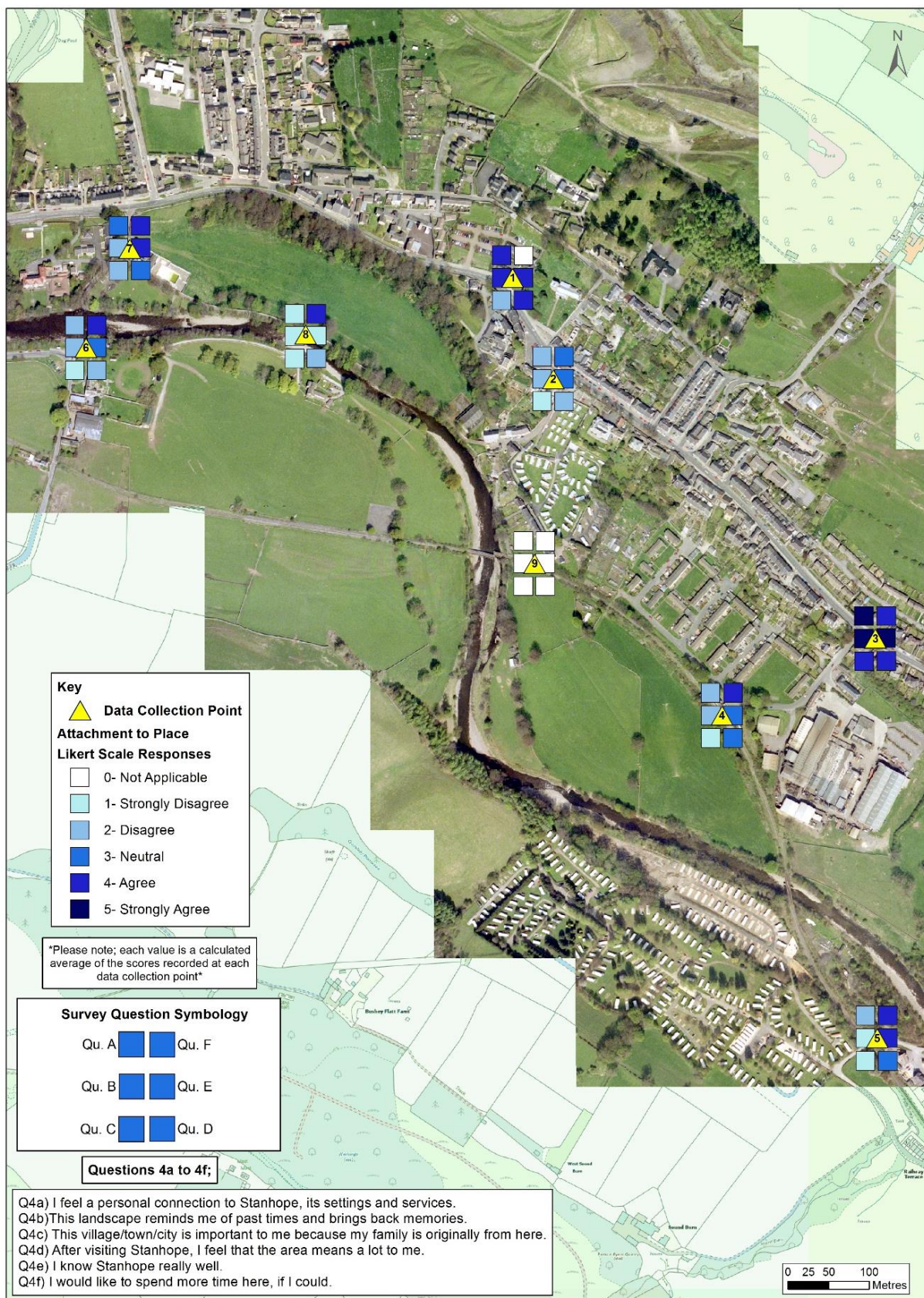
Figure 32F: Qualitative GIS & Likert Maps: Visualising ‘Importance’ on Durham Peninsula, County Durham (October 2016)

Each map presents the findings for each landscape perception theme. Rather than provide a specific analysis of each individual map, I am going to outline the key findings and evaluate the cartographic representations. I will acknowledge the strengths, limitations, and any further necessary considerations. Each figure provides a strong example of how the data collection strategy, qualitative GIS, and colour symbology considerations have been effectively implemented as part of a mixed methodology. I have been able to devise and utilise methods for quantifying description and detail for further manipulation and processing, whilst incorporating a necessary spatial factor to the collated datasets. Each tile or square emphasizes the techniques used to associate colour symbology to the calculated average, whilst providing a visual representation of the content.

Figure 32A suggests that ‘Attachment to Place’ is strongest at DCP5, as the dark blue colouring for all six squares suggests a mean ‘agreement’ to the Likert scale statements. The other DCPs however indicate a wider range of results, with mean values symbolising from ‘strongly disagree’ to ‘agree’. Figure 32B shows similar trends and patterns for ‘Social Relations’, however the white boxes suggest that individuals did not wish to provide a response, or felt it was not applicable to them. DCP5 again showed the strongest indication of evidence. For Figures 32C-F, similar analyses can be made by viewing the relational factors between each DCP and the base map, as it provides further context to support/disprove potential geographical trends and patterns. These maps also provide a degree of storytelling, through the chronological and sequential numbering of the DCPs and Likert statements. Though Yau (2011) pushes for a storytelling quality, these maps are only capable of static representation, like the examples seen previously and in prior chapters, because of limited interactivity (Kirk, 2016). On the other hand, they do allow users to interpret their own version of the tale, where the Likert Maps provide a visual representation of qualitative records and subjective detail and opinion, requiring the user to decipher and develop their own conclusions from the cartographic representation. However, they are not a quick snapshot for interpretation. They are an exploratory tool to prompt investigation, as they require time to interpret the potential meanings of various trends and possible patterns.

The following Figures 33A-C also present people’s perceptions of place, though this time these maps represent data collected across three different data collection periods: October 2016, February 2017, and June 2017. They present data relating to the research site Stanhope, in a bid to provide evidence to support side-by-side comparisons of temporal data. Specifically, Figures 33A-C show the recorded responses associated to the concept of

‘Attachment to Place’, using the same colour symbolisation and data representation techniques as those generated for Durham in Figures 33A-F.



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Figure 33A: Qualitative GIS & Likert Maps: Visualising ‘Attachment to Place’ in Stanhope, County Durham (October 2016)

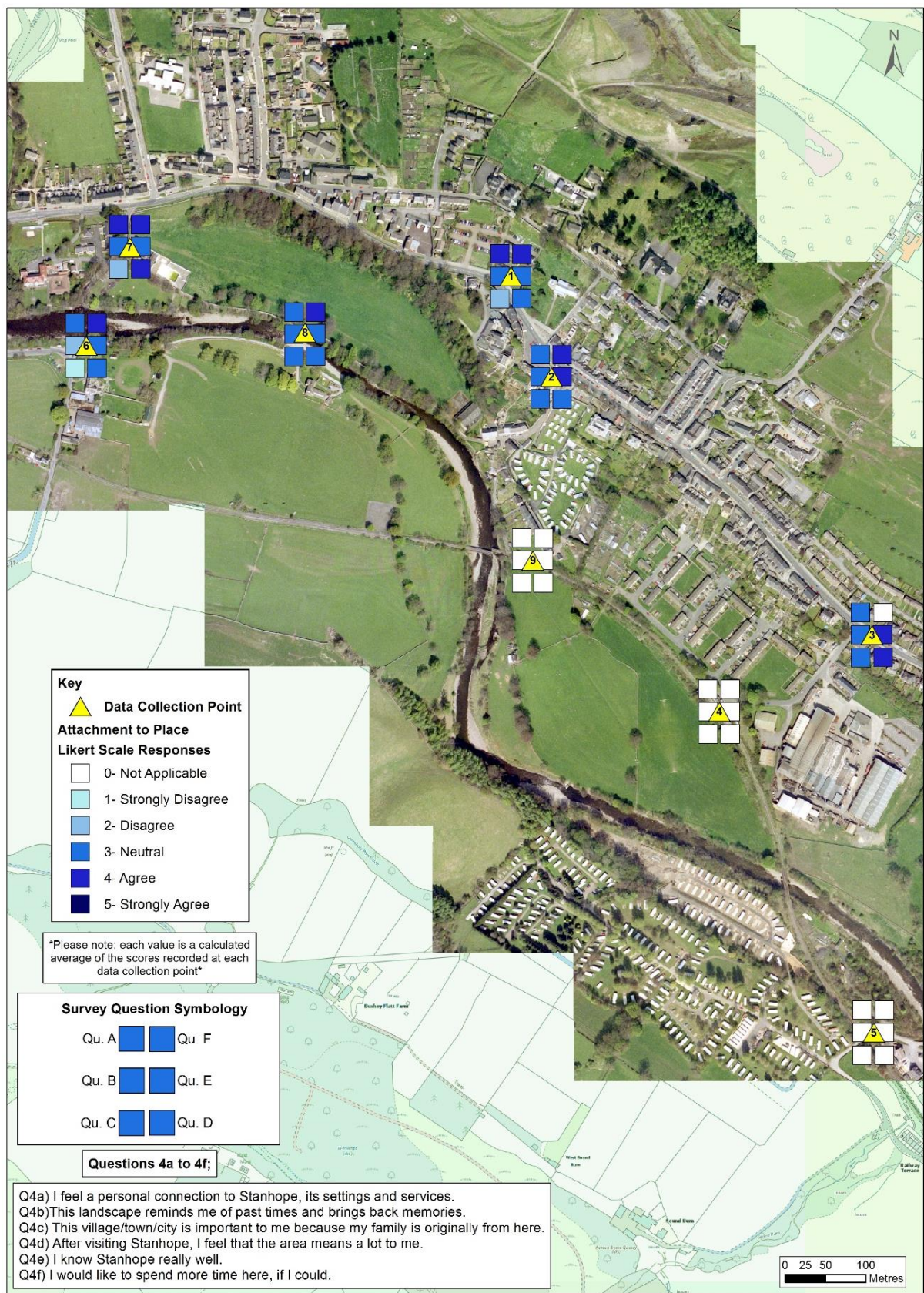
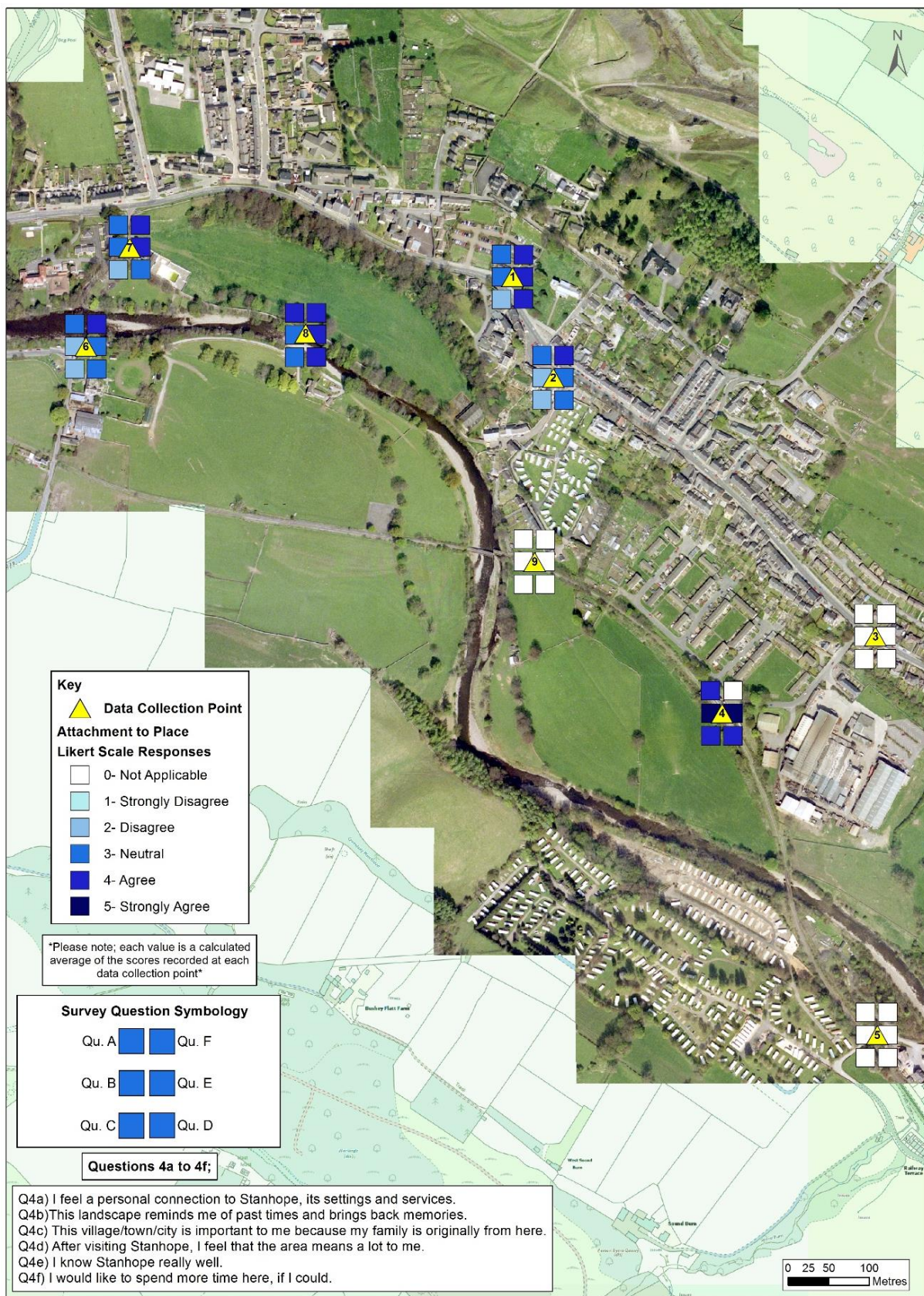


Figure 33B: Qualitative GIS & Likert Maps: Visualising ‘Attachment to Place’ in Stanhope, County Durham (February 2017)



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Figure 33C: Qualitative GIS & Likert Maps: Visualising ‘Attachment to Place’ in Stanhope, County Durham (June 2017)

Considering a temporal analysis of the above Figures 33A-C, these relational charts cannot produce a level of interactivity between the user and the corresponding datasets. They instead facilitate a side-by-side comparison like Figures 32A-F. It would have been possible to overlay the data for each temporal phase (October 2016, February 2017, and June 2017) however, this may have restricted the level of clarity and increased cartographic clutter. These maps required more independent data representations to enable users to clearly determine the resulting comparisons. Subsequently, Figures 33A-C provide a cartographic representation of evidence associated to 'Attachment to Place', with each temporal phase showing different results and patterns visible through the map's symbology. Figure 33A suggests that 'Attachment to Place' was most predominant at DCP3, whilst Figure 33B indicates records of a greater mean value at DCP2. Controversially, DCP7 has an additional dark blue box for 'agree' with questions A, D and F symbolised accordingly, however it has a greater range with a 'disagree' response highlighted for question C. Figure 33C shows stronger evidence of 'Attachment to Place' at DCP8 with responses recorded across all six statements. DCP4 on the other hand presents two statements with 'strongly agree', however, there is a 'not applicable' symbolisation for question F. Furthermore, the most responses associated to the 'not applicable' option appears in February 2017, whether this may be because participants either did not want to provide a response, or felt it was not a question they had the ability to relate to and answer. Additionally, there may have been implications of participant footfall whereby there were fewer participants available at DCPs 3, 5 and 9 to contribute toward the research investigation. Though an assumption, being the colder, winter month of February may have persuaded the availability of respondents.

On the other hand, the issue with this specific research site regards the scale of the map itself. Because of the DCP distribution, the map presents information at a greater scale than those of the Durham as the nine DCPs are spread rather widely across a larger location. This was necessary to cover as great an area as possible and provide a range of settings characterised by unique environmental factors and visual qualities. These representations do, however, facilitate spatial relational and temporal analyses, making this more creative and integrative form of cartographic representation more effective as a medium for presenting both quantitative and qualitative datasets (Cope & Elwood, 2009; Yau, 2011). They can meet both their intended purpose and function as an effective tool of data visualisation (Kirk, 2016). Consequently, Figures 32A-F and Figures 33A-C have provided strong indications that a qualitative GIS can enable researchers to map detail, description, opinion, and perception, to visualise qualitative data through cartographic representation (Cope & Elwood, 2009; Cooper

& Gregory, 2011). Being a relational chart type, it has been possible to develop more creative ways of visualising relationships and connections between specific categories of information (Kirk, 2016).

Designing these Likert Maps has required a continuous cycle of draft, document, evaluate, review, and edit (Krygier & Wood, 2011). Doing so has enabled me to keep a chronological record of how each visual representation was initially designed, constructed, developed, and finally produced. It was appropriate to consider both a) the approach taken by Cooper & Gregory (2011) to visualise aggregated qualitative data, and b) Harper's (2015) rule of providing clearly defined, and equally distributed intervals. Contradictory to Blaikie (2003), the resulting maps were created by associating the average response values to specific shapefiles and plotting them at the corresponding DCPs. Doing so allowed the average response values to be compared visually across a specific geographic location and compared against one another. Consequently, it was possible to utilise the spatial factor which was implemented through the data collection strategy. I remain fully aware that the values are not necessarily statistically legitimate for analysis, though these figures do not need to be tested for correlations and relationships between variables. They are primarily a visualisation of qualitative data, turning the detail and description into formats that are manageable by computers and the relevant software.

To test the effectiveness of the Likert Maps, small-scale usability testing was conducted to consider how effective cartographic representations (i.e., maps) are at presenting people's emotions, feelings, and responses. It involved asking participants to observe and assess a range of maps that presented this information in a variety of different ways and consider the effectiveness of each.

6.4.3 Usability Testing

'Maps have the potential to display the geographic patterns of millions of statistical data points, something impossible using a tabular display. A poorly designed map, however, can fail to convey important underlying features in the data or can even distort their true geographic patterns' (Pickle, 2003:1)

Cognitive experiments and usability tests have a key role in ensuring maps can communicate information clearly, effectively, and accurately to their intended audience. The variety of visual representations and forms of cartography available for presenting information are

expansive, but so are the various tasks and levels of engagement between the visualisation and reader (Pickle, 2003). The research turned to investigate the cognition of map reading and interpretation, specifically regarding the Likert Maps as a more innovative, creative method of communicating spatial data about landscape perception at cultural heritage sites. Using Herrmann & Pickle (1996:), this research drew upon their proposed multi-stage model of cognition to explore how more qualitative forms of cartography are received and met by a target user group, including ‘(1) map orientation ([being] what is this map showing?), (2) legend comprehension, (3) integration of the map and the map legend, and (4) discernment of spatial patterns and relationships.’ By doing so, the usability testing could assess the map style, legend design, colour choice, and responses to task-based questions asked regarding the presented map. For this research, the methods of testing the usability included designed experiments framed as task-based handbooks and following focus group discussions, that invited participants to expand on their answers and provide further thoughts about the various maps. Their evaluations were directed towards six, newly innovated Likert maps, organised into three specific themes (see Appendix F).

Usability Planning & Procedure

The usability testing was designed to be completed in two parts, due to complications and restrictions surrounding in-person research⁷⁹. Having completed the necessary ethical documentation and necessary participant consent was received, participants were sent a ‘Usability Tasks Handbook’ containing details of the study and research context, alongside access to a web-based collaborative platform (SharePoint) where they could access each of the six maps. Once completed, these handbooks were emailed back to me for collation and analysis. The second part of the testing was the focus group discussion, designed as an informal conversation about the usability tasks and the corresponding Likert maps. Its purpose was to discuss participants’ thoughts and ideas about the various maps and acquire further detail/justification for their answers. These sessions were recorded through Microsoft teams and subsequently analysed to supplement the data collected in the completed surveys.

The usability testing drew on several literatures to create an effective map usability test for this research. To underpin the designing of the test, a brief description of the process is

⁷⁹ This was due to the Coid-19 pandemic stemming from March 2020, whereby all in-person contact was refrained, and the United Kingdom placed under national lockdown. Consequently, the usability testing was held online using Microsoft Teams to host and record the focus group discussions, to ensure some usability testing could still be carried out and contribute towards this doctoral thesis.

provided in relation to the supporting literature. Please see Appendix E for details on the Usability Tasks Handbook, of which associated sections will be referred to next.

The ‘Usability Tasks Handbook’ opens with a ‘Welcome!’ page designed to provide details of the study alongside final reminders on the research purpose, that participation was voluntary, and each focus group would be recorded. It provided context about the map usability testing, specifically the three different genres of Likert innovations and the associated datasets. Each map presented data collated through the questionnaire at Durham during the first data collection phase (October 2016), focusing specifically on the Likert scales that gathered evidence of ‘Attachment to Place’ (see Appendix B, questions 4a to 4f). I also provided a map of the DCPs around Durham peninsula, identifying each of the collection points so that students could access context about the locations where the data was collected, acquire the spatial context for associating a geographic reference to the dataset and be subsequently plotted across each research location.

The handbook is structured thematically by each genre of Likert map. Each map has a corresponding survey for students to complete tasks and evaluate the designs, and these are replicated across each for consistency. The tasks, however, do differ slightly due to participants being able to acquire increased familiarity with the corresponding dataset. Each section is split into four parts. The first is the starter activity whereby the purpose of this was to initiate participant engagement with the map innovation and ensure that they could read the provided maps, ensuring participants could determine the use of each (Pickle, 2003; Nusrat, *et al.* 2015). They were also asked to indicate their first impressions of the Likert map using the below Likert scale:

Using the scale below, please indicate your first impression of the Likert innovation map:

N/A	Very Poor	Poor	Average	Good	Excellent
☐	☐	☐	☐	☐	☐

The second section was the task-based testing designed to test how participants, as map users, explored the data, looking for similarities and differences, interpreting findings and observing the patterns and trends within each Likert map. Like Koenig, *et al.* (2011) and Nusrat, *et al.*

(2015), users could visually explore the representations and respond to specific questions, to help them develop an opinion and/or preference as part of the evaluation process. The tasks enable the users to explore the data and find data relations, as well as summarise and identify key information. Observing Appendix E, the tasks were designed with Nusrat, *et al.* (2015) approach to evaluating cartograms, and adapting this to accommodate this research context and Likert maps. The tasks included locating data corresponding to searching and finding specific details in the representation, recognising the location of the data points to provide further context and add detail to their task answers, finding the ‘top-k’ which requires finding specific values of an attribute, and a summary task which asked participants to summarise trends and patterns with the research (Nusrat, *et al.* 2015:1105). In doing so, the questions were also able to follow Bertin’s (1983) general classification of questions regarding graphic data use, such as data read out, patterns within a graphic, and comparison (though this was not a direct question, participants did compare the representations in the focus group discussion).

The third section draws on Pickle (2003) whereby this was split into three parts (map style, legend design, and symbology and representation), with a series of Likert scales that required participants to acknowledge the extent to which they agreed/disagreed with a specific statement. However, as each map has slightly different design principles and characteristics, these were tailored to each specific type of Likert map innovation. This cognitive experiment asked the participants to consider the map design (i.e., basemap, arrangement of contents, labelling, visual appeal, and ease of interpretation), the legend design regarding clarity and ability to provide necessary and information about the map’s contents, and symbology and representation including colour choices, graphical representations/symbology (where applicable), readability, and overall understanding. Participants were asked to rank their thoughts about each using the provided Likert scales, and offered the opportunity to provide further detail and justification in the focus group.

The fourth section also draws on Nusrat, *et al.* (2015) and their approach to attitude testing. Participants were asked to rate each cartographic representation according to specific categories, such as helpfulness, appearance, design quality, using a five-point rating scale between pairs of opposite words and phrases. In doing so, it was possible to visualise participant preference for each of the maps and assess how helpful, interesting, innovative, and clear each of the Likert designs were. The results are presented after the next section on recruitment.

The final section of the handbook titled 'Cartographic Preference' asks the participants to select one of the six maps which they identified as their favourite, and one which they identified as their least favourite. This was purposely done after participants had completed the various tasks and attitude tests, having also been asked for their first impressions of the maps at the very start of the handbook. In doing so, it enabled participants to draw on their experiences of using and evaluating each of the six maps and reflect on the reasons for their favourite/least favourite. Nusrat, *et al.* (2015) also do this in relation to their research on evaluating cartogram preference, to find out more about the subjective details that underpin participant choices, and in this case, regarding the responses given throughout the evaluation of the six maps.

Usability Recruitment

For this research, I recruited participants from a Level 3 cohort of undergraduates at Durham University enrolled on the current academic year (2020-2021). Specifically, the usability testing was aimed at students who had completed two practical blocks of GIS-based research methods training, as part of their Level 2 work on Social Research Methods. Having been the tutor for both parts of this module, I chose to select participants that I knew had received the minimum relevant training and familiarity to take part and complete the usability testing. The usability testing drew on some of the basic skills required for reading cartographic representations and interpreting the presented data, of which I taught as part of both social research methods blocks. Though these may be perceived as limitations to the usability study (such as Koenig, 2011), I justify my recruitment and sampling choices by arguing that the small-scale study could be used as a pilot study, prompting explorations and further testing as part of wider research. A small sample size could encompass a range of expertise, aside from the parameters I used to select and recruit the undergraduates, varying from those relying primarily on their taught university skills through to those who may be more familiar with mapping practices and GIS. I have no control over this quality; however, each participant did engage and provide feedback to suggest improvements (Bhowmick, *et al.* 2008; Koenig, 2011). Additionally, a significant limitation regards my choice of engaging with students as part of their academic training, rather than with being a wider study with heritage associated professionals and organisations (Dumas & Redish, 1999; Koenig, *et al.* 2011). For the context of this research, I feel it was appropriate because these individuals did have some experience and training in data analysis and the use of GIS (Koua & Kraak, 2004). Whilst they may not entirely representative of the target population, being other academics and likely readers of

future publications, they are however a part of the larger audience that do engage with such materials as part of their own academic development and studies.

With confirmed ethical approval from both Newcastle University and Durham University⁸⁰ the recruitment process began over the summer (2020) via email communication. Forty-three students were contacted, and ten participants responded with interest. I sent out the necessary participant information sheet (see Appendix C) and consent forms (see Appendix D) alongside a doodle poll, to arrange the focus groups for a time of unanimous availability. However, due to a minor complication with residential location and circumstances, one student was unable to attend the focus group discussions though did still contribute a completed handbook with their evaluation of the Likert maps. This meant that I had two groups for the focus group discussions: a group of four, and a group of five. Once I had the necessary consents, I was able to send out details outlining the logistics of the project. Each participant received a Usability Tasks Handbook (see Appendix E) that was to be completed prior to their arranged focus group discussion. I used SharePoint to create a private group and provide the necessary map documents, whereby there were three folders containing each theme of innovation: Likert Pie Chart Map of Attachment to Place, Likert Grid Map of Attachment to Place, Likert Radar Map of Attachment to Place (see Appendix F for copies of the maps). Within each of these folders were two maps that required their assessment and evaluation. The participants were asked to read the Focus Group Handbook, whereby the 'Welcome! Page' provided further details about the project and the maps they were going to be assessing. They were each asked to follow the instructions to the surveys in relation to each map and complete a series of tasks about the various designs, purpose, and ability to effectively communicate information. The responses were recorded using a series of tick-boxes and short-answer questions. Once completed, these were sent back to my email address and stored securely.

Usability Results

The following data graphics have been devised to present the findings from the Usability Handbooks. Specifically questions one, four and five have been analysed and presented in the following data graphics. The results regard a sample size of ten participants.

⁸⁰ Ethical approval was sought from both institutions as Newcastle University, UK is the host of this doctoral research and Durham University, UK is my place of employment, where I was able to recruit participants for the usability testing.

Please note that each Likert Map innovation has been numbered in accordance with the Usability Handbook. The labels on each on the graphed results correspond to the following:

Map Group	Number and Innovation Details
Likert Pie Chart Map	▪ (1)- ESRI Streets Basemap ▪ (2)- ESRI Streets Basemap with Nested Legend
Likert Grid Map	▪ (1)- ESRI Streets Basemap with Questions Outlined ▪ (2)- ESRI Streets Basemap without Questions Outlined
Likert Radar Map	▪ (1)- ESRI Streets Basemap Charts with Question Number ▪ (2)- ESRI Streets Basemap Charts with Question Description

Question 1. Start Activity: First Impressions

The start activity for each corresponding map asked participants to indicate their impressions of the associated Likert map. The results are as follows:

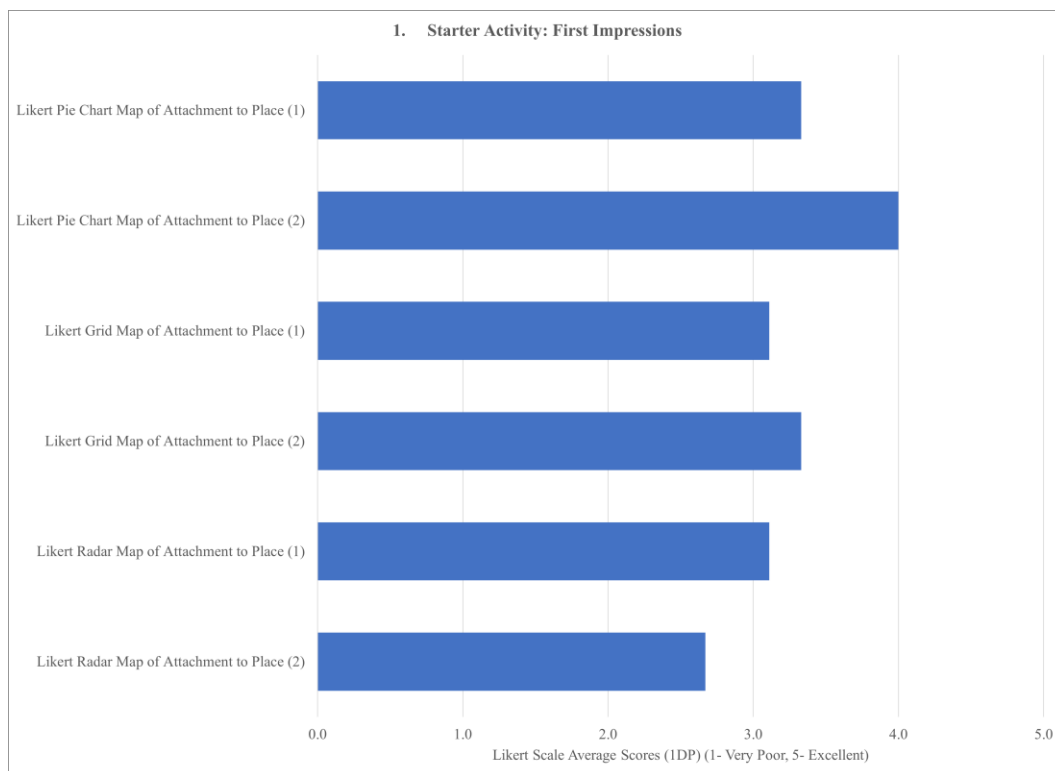


Figure 34: Question 1. Starter Activity: First Impressions Results

Based on first impressions, Likert Pie Chart (2) was the most positively impressionable with an average of four correlating to a ‘good’ map. The least impressionable was Likert Radar (2) which scored an average of around 2.7, meaning it was perceived to be a ‘poor’ map.

Question 3. Design and Aesthetic Testing

For each section of the Design and Aesthetic Testing (i.e., map design, legend design, symbology and representation) I have aggregated the average values of each criteria to produce a value by testing theme. The results for each map are as follows:

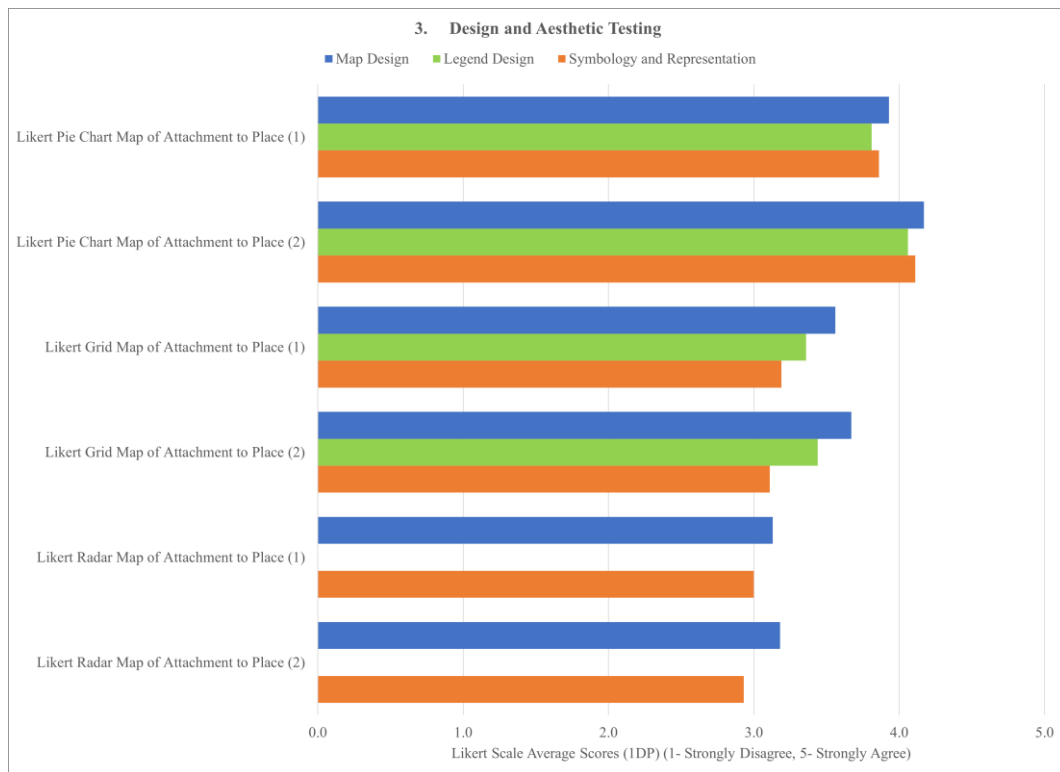


Figure 35: Question 3. Design and Aesthetics Testing

Likert Pie Chat (2) had the best map design acknowledged with a Likert average of 4.2 suggesting participants agreed that the map was of good design, in relation to each of the criteria. Likert Radar (1) produced an average response of 3.1 meaning participants neither agreed/disagreed about the quality of the map's design.

Legend design was not assessed in the Likert Radar maps as these did not contain a key in the map's design. Likert Pie Chart (2) produced an average Likert response of 4.1 suggesting participants agreed the legend was of good design, whilst Likert Grids (1) and (2) were the lowest ranked at 3.4.

Symbology and representation showed similar results to the map design, with Likert Pie Chat (2) producing the highest Likert average of 4.1 meaning participants agreed that it was clear, effective, and easy to use. Likert Radar (2) however received the lowest Likert average at 2.9, whereby it was deemed the symbology and representation were poor.

Question 4. Attitude Testing

The fourth section required participants to rank each Likert innovation according to a specific category. Using the five-point rating scale between pairs of opposite words/phrases, the results are as follows:

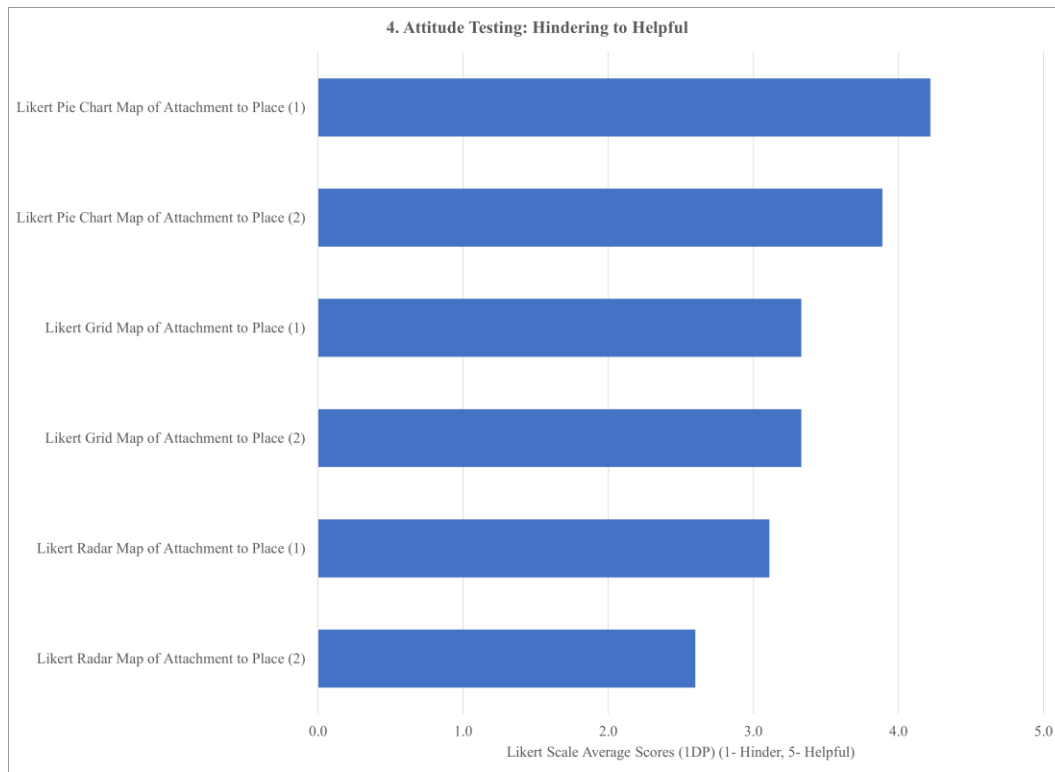


Figure 36A: Question 4. Attitude Testing: Hindering to Helpful Results

Likert Pie Chart (1) appears to be the most helpful map with an average score of 4.2, whilst Likert Radar (2) appears to be the least helpful with an average of 2.6.

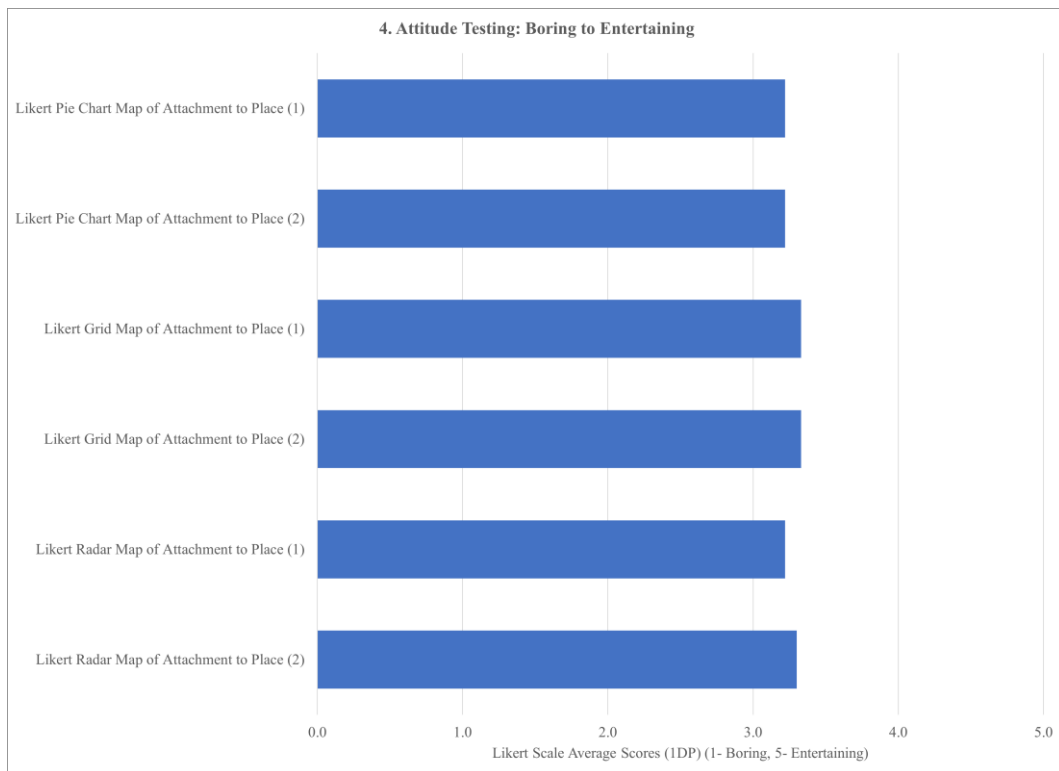


Figure 36B: Question 4. Attitude Testing: Boring to Entertaining Results

There is very little differentiation between the scores for entertaining to boring, with only 0.1 between the lowest and highest recorded averages values. This suggests all the maps are neither boring nor entertaining to use.

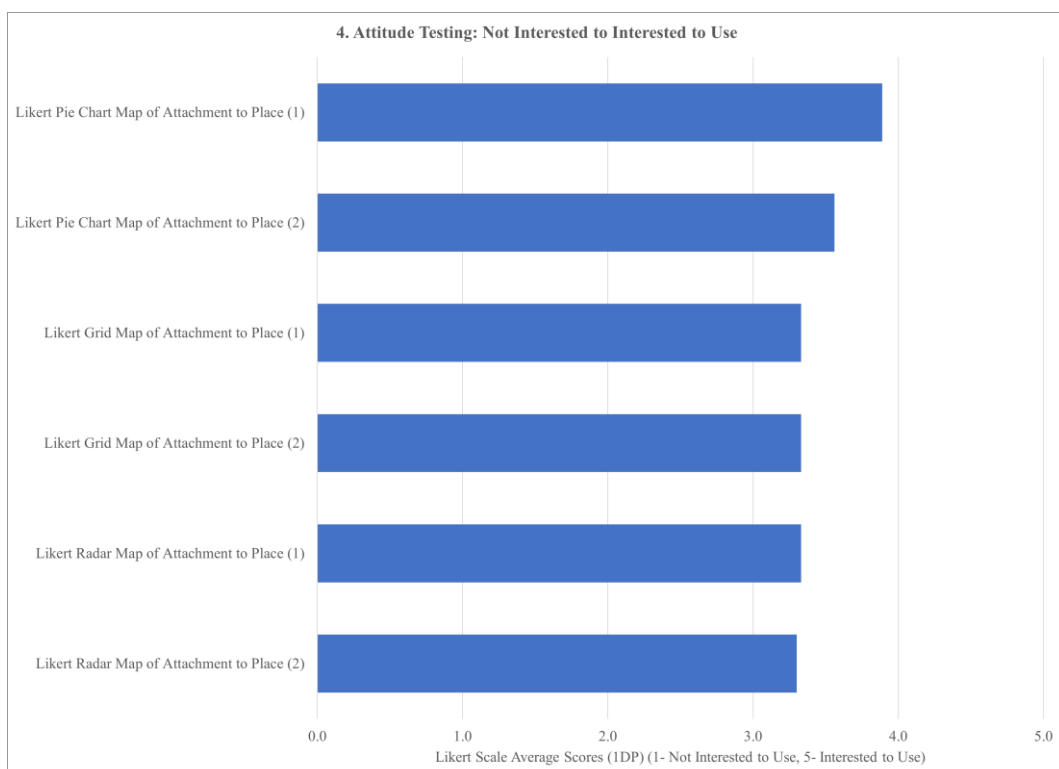


Figure 36C: Question 4. Attitude Testing: Not Interested to Interested to Use Results

Likert Pie Chart (1) was the most interesting map to use, according to the presented average values of 3.9, whilst all Likert Radar and Grid maps present an average of 3.3 suggesting neither interest nor lack of interest to use.

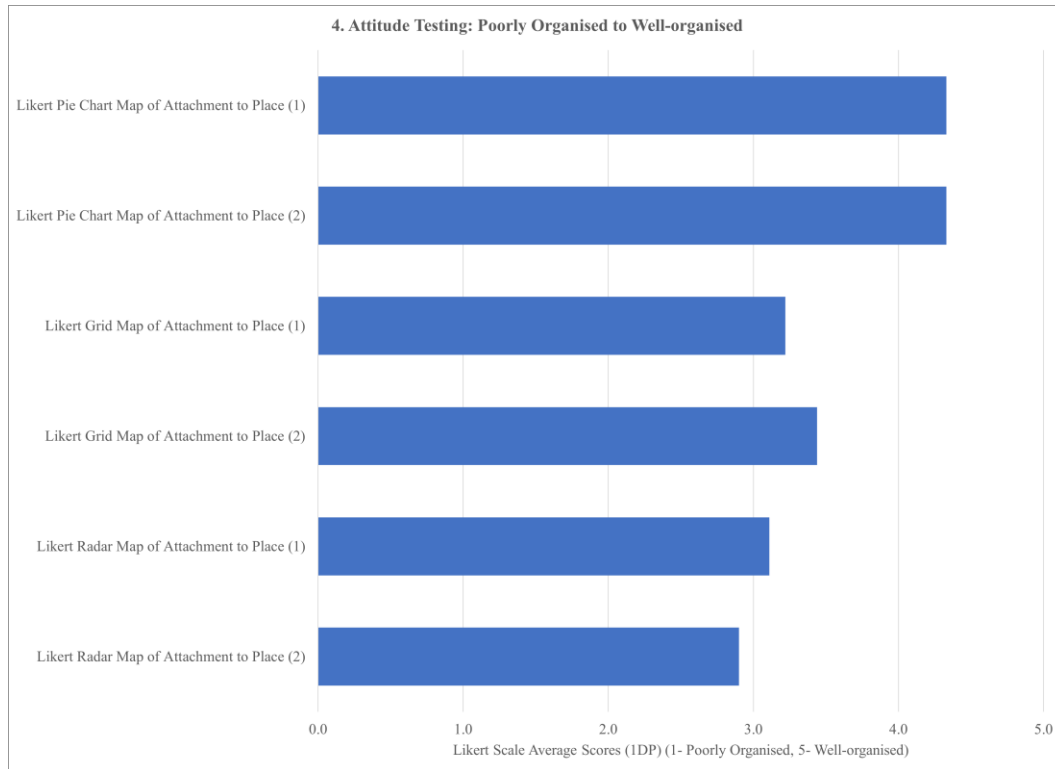


Figure 36D: Question 4. Attitude Testing: Poorly Organised to Well-organised Results

Regarding organisation, Likert Pie Chart (1) and (2) both resulted in an average of 4.3 suggesting these maps were well-organised. Likert Radar (2) on the other hand was the least well-organised with an average of 2.9.

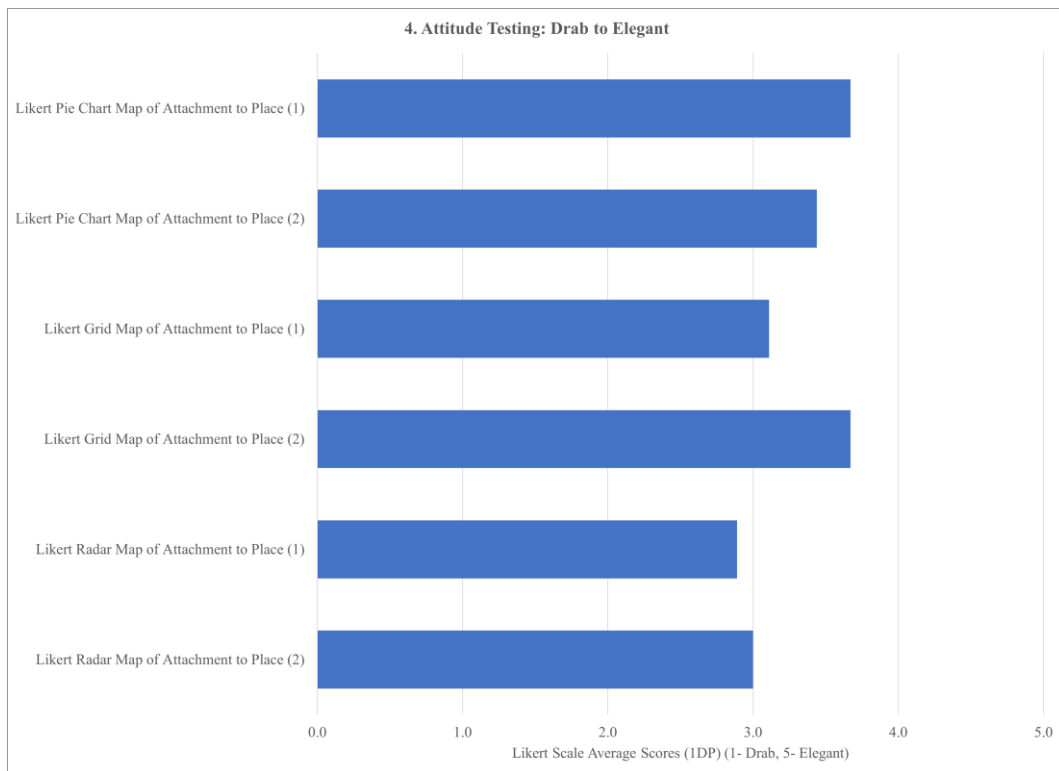


Figure 36E: Question 4. Attitude Testing: Drab to Elegant Results

Likert Grid (2) was deemed the most elegant with a value of 3.7, however in terms of the scale, this suggests participants were neutral about their attitudes towards elegance. Likert Radar (1) was the drabest out of the representation with an average of 2.9.

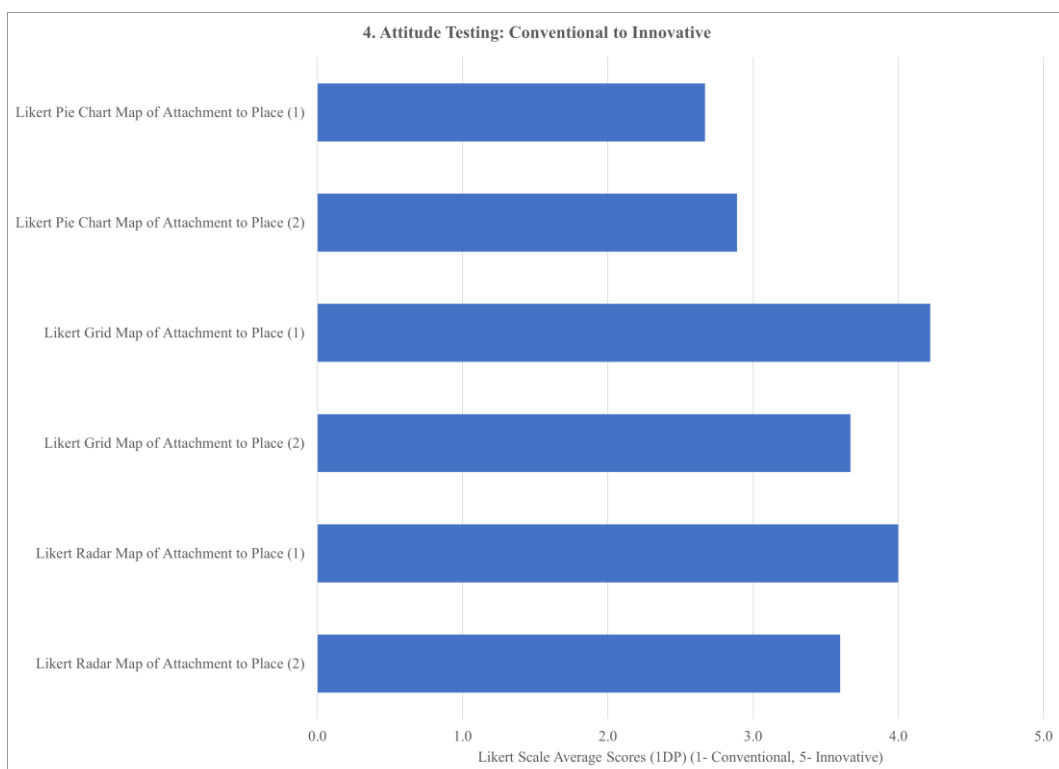


Figure 36F: Question 4. Attitude Testing: Conventional to Innovative Results

Regarding innovation, Likert Grid (1) scored the highest average with 4.2 suggesting the representation was deemed innovation in its design and creation. Likert Radar (1) followed closely behind with a value of 4. Both Likert Pie Charts were deemed quite conventional with scores of 2.7 and 2.9.

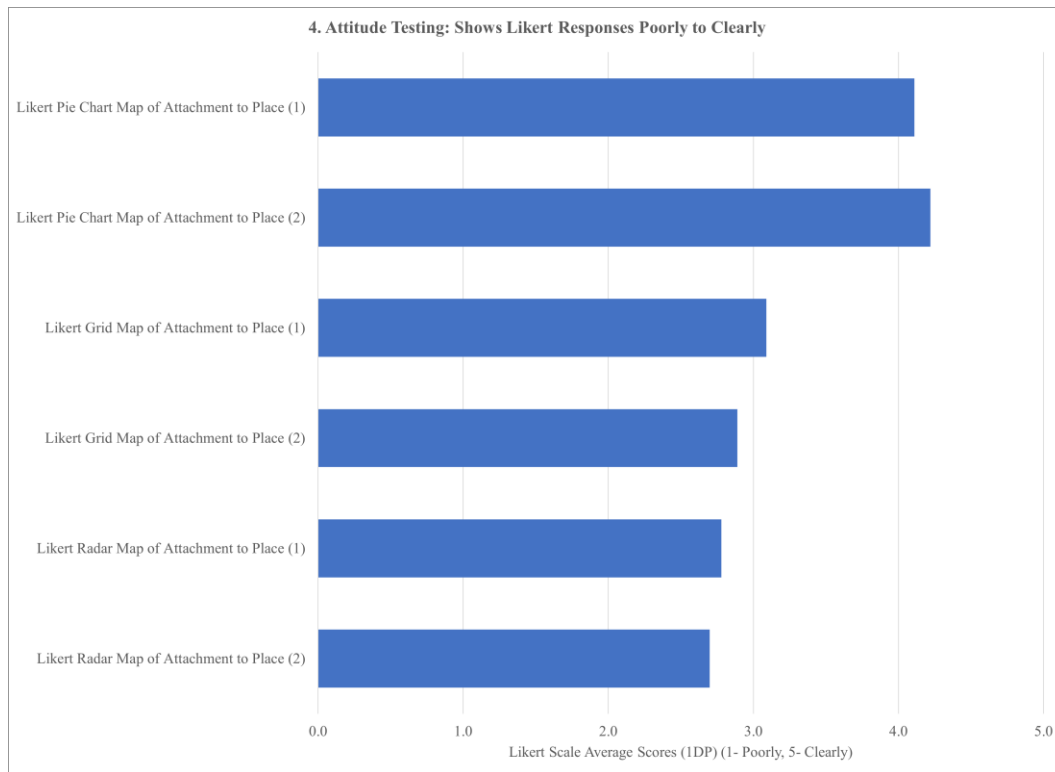


Figure 36G: Question 4. Attitude Testing: Shows Likert Responses Poorly to Clearly Results

Likert Pie Chart (2) scored an average of 4.2 whilst Likert Pie Chart (1) followed closely behind with a value of 4.1. The map with the least clarity was Likert Radar (2), with an average response value of 2.7.

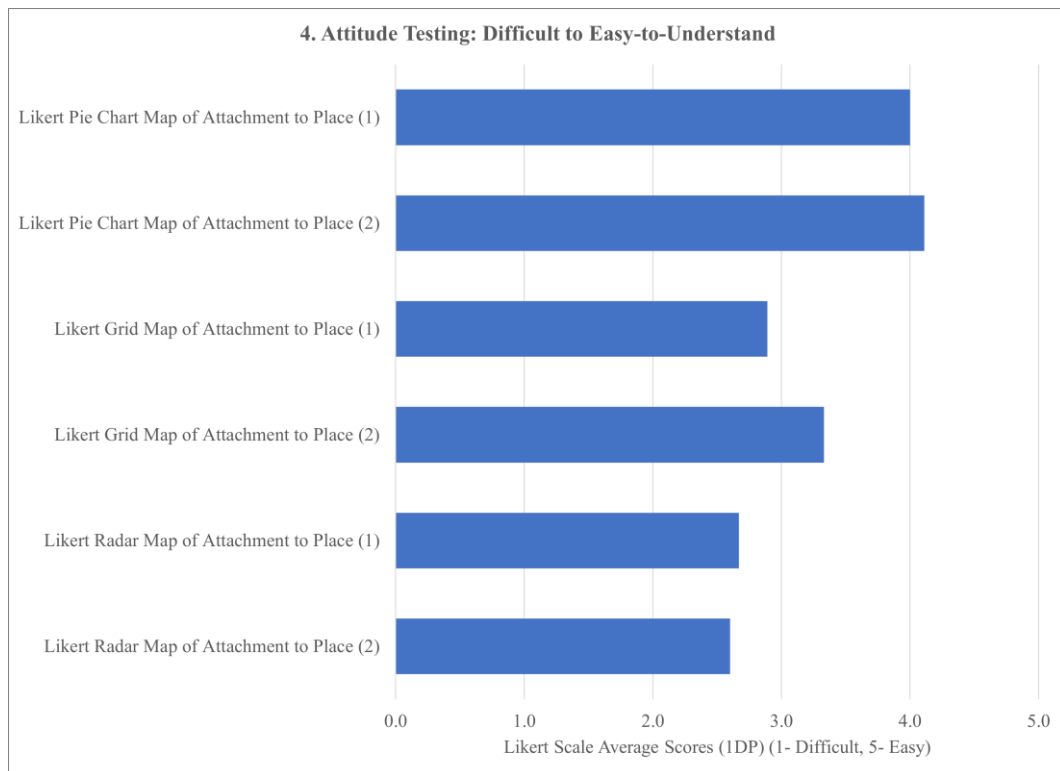


Figure 36H: Question 4. Attitude Testing: Difficult to Easy-to-Understand Results

The final category for attitude testing regarded difficulty to ease of understanding the various cartographic representations. Likert Pie Chart (1) scored the highest value of 4.1 and Likert Pie Chart (2) followed closely with a value of 4, suggesting the pie chart designs were the clearest and easiest to understand. Likert Radar (1) and (2) scored 2.7 and 2.6 respectively, suggesting these were the most difficult to interpret and understand.

To summarise, out of the eight attitude categories listed, Likert Pie Chart (2) received the highest average scores across six of the categories outlined under the attitude testing, suggesting this representation was the most effective and well-met. Likert Radar (2) however, received the lowest average scores across seven of the categories, deeming this one the least effective and usable maps of the collection.

Question 5. Cartographic Preference

The fifth and final section asked participants to reflect on each of the six maps and consider which was their favourite and least favourite. The results are as follows:

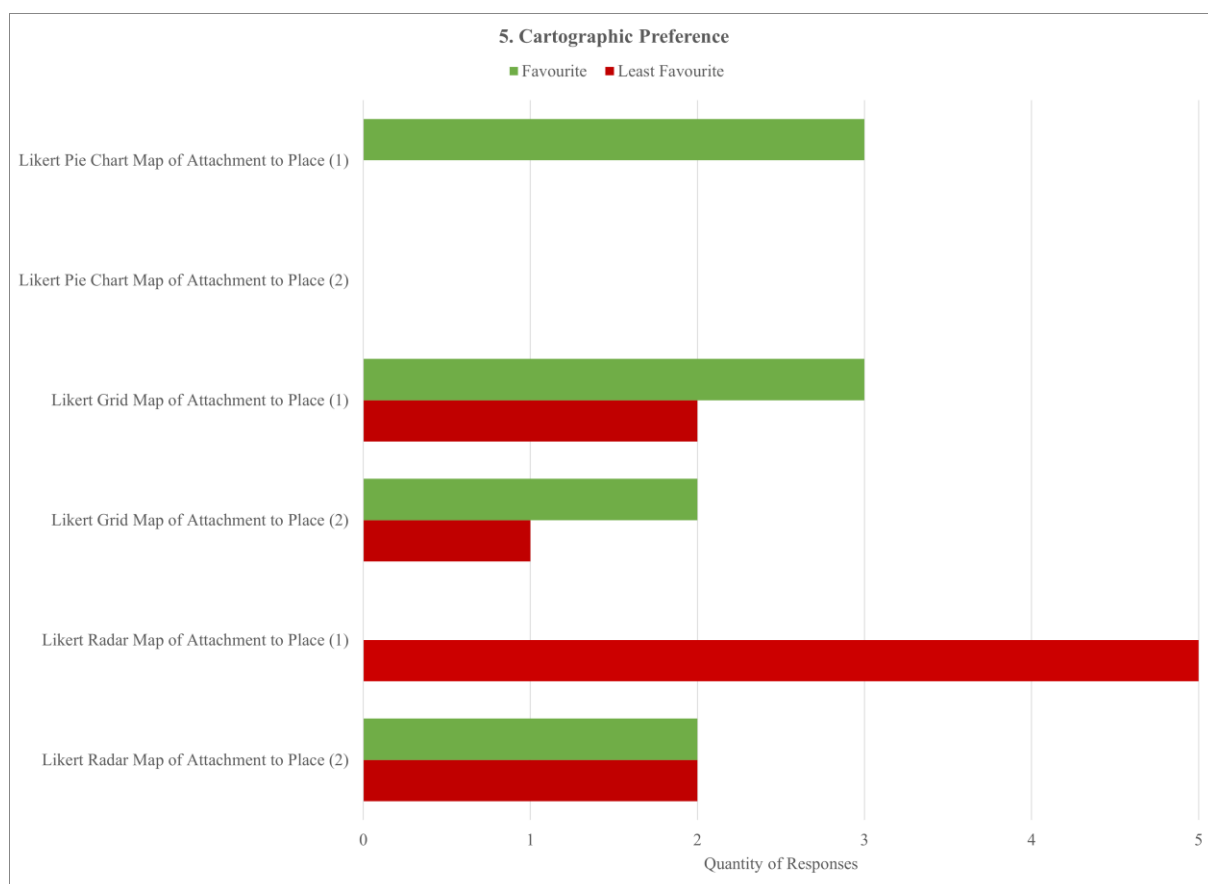


Figure 37: Question 5. Cartographic Preference Results

Likert Pie Chart (1) and Likert Grid Map (1) were deemed common favourites between the participants, with three individuals identifying these as such. There is however, a clear least favourite in Likert Radar Map (1) with 50% of the responses identifying this as such.

Compared to the first impression results whereby Likert Pie Chart (2) has the best first impression, the cartographic preference is divided evenly between Likert Pie Chart (1) and Likert Grid (1). The least impressionable was Likert Radar (2) which suggested it was perceived to be a ‘poor’ map, however the final cartographic preferences suggests Likert Radar (1) is the least preferred map innovation.

Usability Conclusion

Once all the findings were aggregated together, Likert Pie Chart (2) appeared to rank the highest across five of the categories tested for in the usability test, being: the first impressions, map design, legend design, symbology and representation, and attitude testing. Likert Radar (2) ranked the lowest across three of the categories, being: first impressions, symbology and representation and attitude testing. However, the results differed when participants were asked to reflect on their cartographic preference, drawing on their experience and understanding of

each map, having engaged with the innovations during the usability test. Likert Pie Chart (1) and Likert Grid (1) were deemed the most preferred forms of representation for visualising attachment to place, whilst Likert Radar (1) was the least. Likert Radar (2) scored the lowest response values across the usability survey; however, Likert Radar (1) was deemed the least preferred representation presented. Surprisingly, two people did prefer Likert Radar (2), contrary to the evidence shown.

Notably, correct answers were not a key factor so long as the participants were able to navigate each of the Likert Map innovations. However, they did provide evidence of the effectiveness of each map (Brewer & Pickle, 2002). In places, the participants reported to have found it difficult to complete some of the task-based questions due to map reading issues. Specifically, the Likert Grid maps, and Likert Radar maps were harder to engage with and decipher the meaning from the map symbolisation because of the issues with its contents, whereby the Pie Chart maps were better received as these are a much more familiar representation to the users. However, it is necessary to include these sorts of questions and tasks to better evaluate the functionality and purpose of the maps (Brewer & Pickle, 2003).

The usability testing enabled an enquiry into the subjective aspects of the Likert maps regarding aesthetics and overall design. The subjective evaluation served as an initial step in the evaluation of these newly developed cartographic representations, testing the maps themselves rather than searching for answers to a specific hypothesis (Sterba, *et al.* 2014). To improve these maps and retest them further, the next step would be to deploy traditional qualitative approaches again with further objective applications (i.e., combining the quantitative with the qualitative), using web-based platforms to enable easier sharing (Sterba, *et al.* 2014). There is further potential to make use of additional technologies and tools to investigate the relationship between map design and the cognitive processes that map users employ (Griffin, 2017). Specifically, making use of eye-tracking technologies would enable me to test these maps with further rigour to better understand and assess the data visualisations regarding efficiency and engagement. It would allow a further insight into the relationship between visual displays and human cognition, relating to the communication of knowledge (Harrower & Fabrikant, 2008; Wilson, 2017). These maps will never be perfect, but so long as they meet their purpose and support their function as a data visualisation tool, they can and do work.

The chapter will now explore an example where this spatial quality has been removed and the resulting data representations associate more with the data graphic genre of visualisation.

Introducing Sankey diagrams, these are designed to visualise the flow of information and showcase either quantity or relationships between categories of data.

6.5 Sankey Diagrams

Sankey diagrams are a series of data graphic designed to visualise flow. Specifically, Sankeys are renowned for their use within energy, engineering, and industry, to visualise the flow of energy, resources, materials, and other associated variables (Schmidt, 2008, Lupton & Allwood, 2017). The diagrams themselves contain two key features: 1) represent the physical flow in relation to a specific unit or time, and 2) the magnitude of each flow can be represented by the width of each link, including mass or energy (Schmidt, 2008). These data graphics are produced using various computational software, either desktop-based or through online applications including DisplayR which was used in the construction of the data visualisations seen in this chapter.

Sankeys can also be used to visualise multidimensional data and from a data visualisation perspective, and these differ to the more ‘traditional’ examples of Sankey diagrams. Specifically, Kosara, *et al.* (2006) uses Sankey diagrams to describe passenger data on the Titanic using ‘ticket class’ and ‘gender’ as dimensions with the width of the link representing quantity. They differ to the previous example by Schmidt (2008), because the links between different attributes are shown, rather than physical flow. This type of Sankey has also been used within aspects of engineering to visualise global greenhouse gas emissions (Bajželj, *et al.* 2013), where the different dimensions are categories, such as equipment, fuel, and emissions. Both types of Sankey are useful for visualising data flows and making clear the complexity, through intuitive readability and transparency (Schmidt, 2008). In this thesis, Sankey diagrams are used to visualise survey data, using the questionnaire⁸¹ designed for this thesis to underpin the design. They encompass qualities of both variations of Sankey diagram, by presenting the flow of answers in relation to the questionnaire’s completion but also how many participants gave that specific response. The Sankey diagrams enable the user to visualise the magnitude of responses but also the links between each category of question.

6.5.1 Riall Sankey, Charles Minard and Exploratory Data Analysis

Captain Matthew Henry Phineas Riall Sankey (1853-1925) unknowingly created one of the first examples of a Sankey diagram, through his work on steam engines and turbines (Sankey,

⁸¹ See Appendix B

1896, 1898; Schmidt, 2008). The first diagram, known as the ‘temperature-entropy diagram’ (Sankey, 1896) was not the subsequent ‘Sankey’ but the research that it was associated to, was the starting point. This work was commissioned as part of a report on steam engine efficiency and with this Sankey provided a chart that compared a practical steam engine with a more idealised version that showed thermal flows (see the Figure 38 below). Ten years later, Sankey’s diagrams were being used across the world to promote the use of the gas engine in utilising heat⁸².

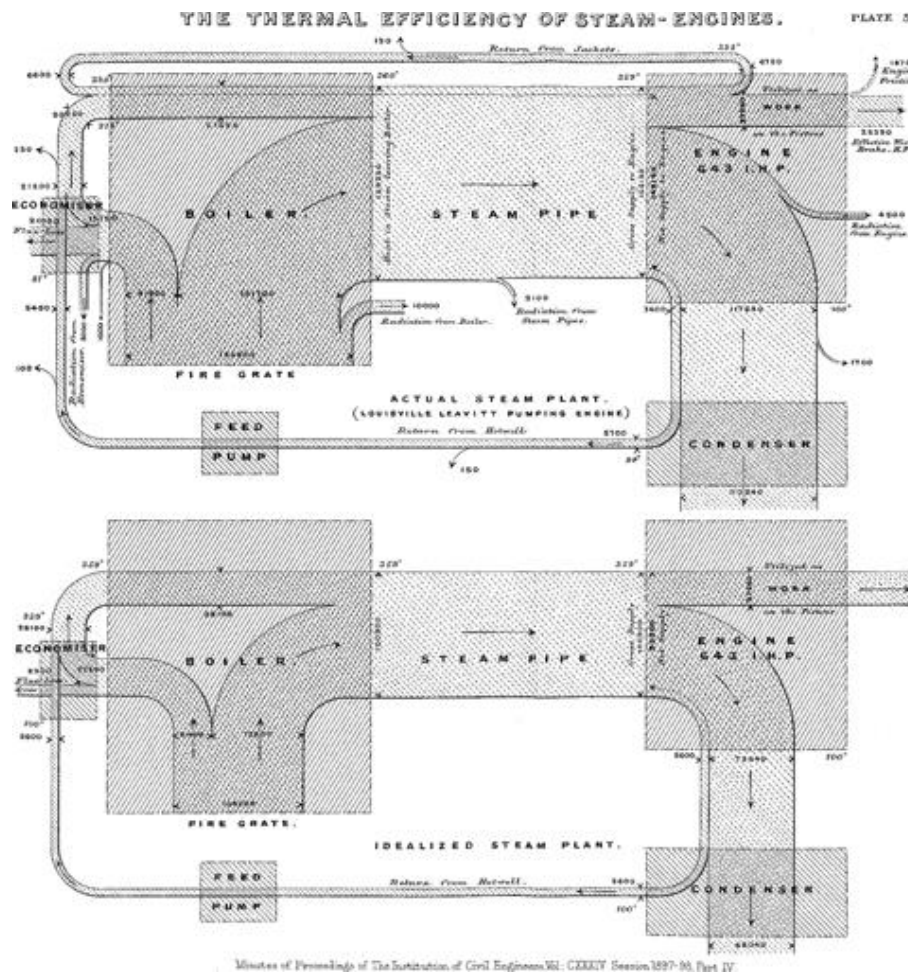


Figure 38: Energy Flow Diagrams (Sankey, 1898, cited by Schmidt, 2008:85)

Notably, another example of a representation with similar qualities to a Sankey diagram has already been introduced within this thesis, being Charles Minard’s 1869 Carte Figurative of Napoleon’s advance and retreat through Russia (1912-1813)⁸³. It too, presents the flow of data, specifically the advancement of Napoleon’s army and the losses sustained both during

⁸² See Schmidt (2008) for details on the use of Sankey diagrams in Germany and key figures/engineers who used these diagrams within their own research.

⁸³ See Chapter 2.0 section 2.3.1 A Brief History of Mapping and Cartography

his attack and the retreat (Tufte, 2001; Schmidt, 2008). It is this diagram that Tufte (2001) claimed to be one of the best drawn, of its time. Today, Sankey diagrams are still being utilised and applied within energy and industrial research (see Li, *et al.* 2017; Hernandez, *et al.* 2018). They are also being used within other fields and with more exploratory purposes, such as Huang, *et al.* (2015) who use Sankey diagrams to analyse electronic medical records.

Expanding on this piece of research further, Huang, *et al.* (2015) developed Sankey diagrams as a form of ‘interactive exploratory analysis and visualisation’ to enable researchers to study various cohorts of patients over time. The purpose was to uncover details and potential patterns within their patient datasets and determine critical factors that may persuade and/or influence chronic kidney disease, such as age, gender. They argued that visual analytical techniques enable decision makers to see patterns and anomalies in a more effective, accessible form, enabling the user to access comprehension and memory in the decision-making process (see Basole, *et al.* 2015 for another medical example). An example of their results is shown below in Figure 39, showcasing the trajectories of various patients. They have used various levels of aggregation to sort their data into relevant categories, being patients into various cohorts by severity of illness, to visualise clinical courses without oversimplification (Huang, *et al.* 2015).

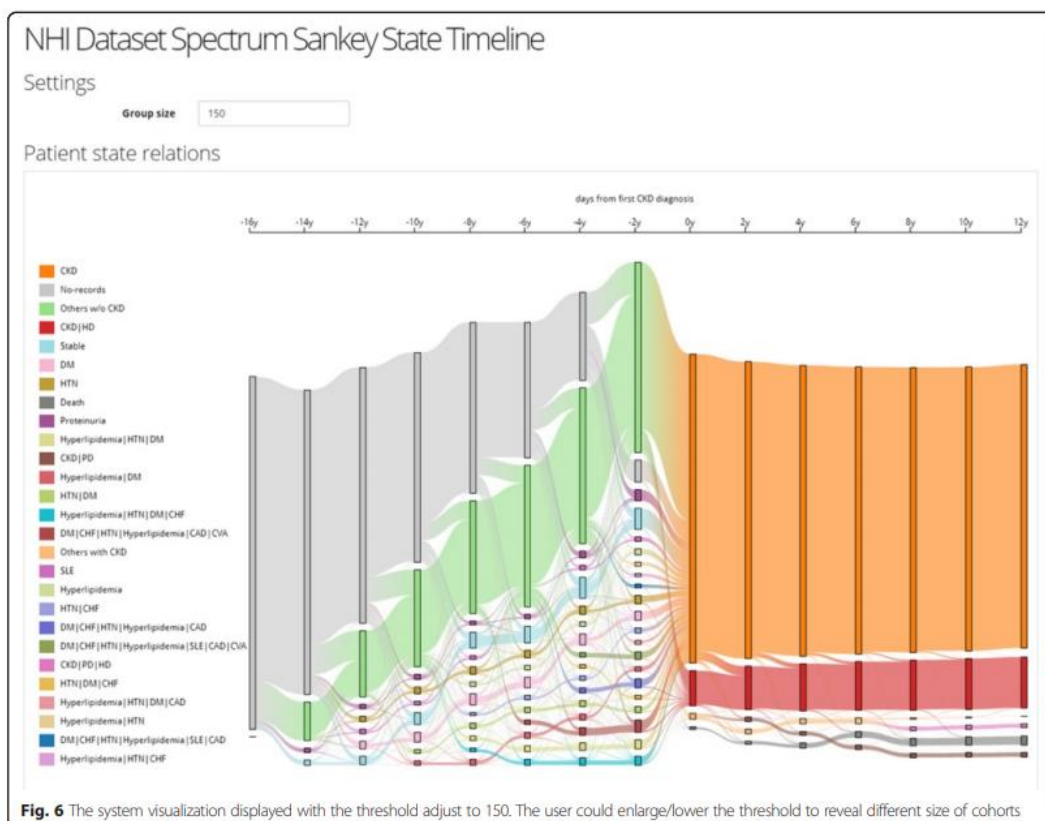


Figure 39: ‘Frequency-based Cohort Clustering’ (Huang, *et al.* 2015:14)

Though only two pre-examples of Sankey diagrams have been presented, the capability of the visual technique to support different fields of research and with different purposes supports further applications of the method within the context of this research. Specifically, using Sankeys as a method of exploratory data analysis and presenting the survey data from each of the research areas will enable the visualisation of participant responses, to uncover any potential patterns and anomalies within the datasets but also visualise the variety of information about the participants themselves (Downs & Stea, 1973; Knigge & Cope, 2006, 2009). Though there may not be a specific hypothesis or question to ask of the data itself, these diagrams will provide evidence of their capability to simply explore and learn more about the data, in relation to people and various landscapes.

6.5.2 Survey Sankeys

In this research, DisplayR was used to produce the Sankey diagrams, presenting participants responses collated in the questionnaire. The purpose was to visualise the flow of responses from one question to the next and assess the representation through exploratory data analysis for potential patterns and trends in the provided answers. Notably, as a type of data graphic, there is no reliance on geographically referenced data hence the associated spatial quality regards the aggregation of the survey data by research location. By doing so, the following Sankey diagrams present the results from each of the three research locations during the first data collection period (October 2016). Furthermore, the presented results relate to responses from questions 1 to 2a and questions 7 to 10, as questions 3 to 6 collate Likert responses (see Appendix B), were used previously in the Likert Maps. For this section, I wanted to test the capabilities of Sankey diagrams in presenting other sets of data collected during the research, such as the other quantified responses from the questionnaire.

DisplayR⁸⁴ is a cloud-based application that combines a data science platform for analysing data, with a visualisation application that allows users to export reports and data representations into PowerPoint and Excel (Bock, 2020). It allows users to import data, conduct basic data explorations, perform advanced analysis/data science, and finalise their findings into associated reports. By setting up a new account and making use of a generous free trial (one hundred hours of active use), I was able to choose which data representation I wanted to create and familiarise myself with the platform. I started by tabulating the

⁸⁴ The weblink to DisplayR can be found here and in the bibliography: <https://www.displayr.com/>

questionnaire results for each research location (October 2016) in excel, with each column representing a category (i.e., a question) and each row a participant's response.

Enter or Paste Data								
Enter data manually or use Ctrl-V to paste data from a spreadsheet.								
	A	B	C	D	E	F	G	H
1	Qu1	Qu1a	Qu2	Qu2a	Qu7	Qu8	Qu9	Q10
2	GD	PR	LWS	N/A	VD	M	36-45	N/A
3	WK	PR	LWS	N/A	VD	F	36-45	EO
4	LA	WM, OLN	Y	10+	VD, SM	M	46-55	PO
5	GD	PR	LWS	N/A	VD, SM	F	18-25	SC
6	LA	WM, OLN	Y	10+	VD	F	46-55	CL
7	GD	PR	LWS	N/A	VD	M	36-45	AP
8	LA	PR	LWS	N/A	VD, WL	F	66-75	CR
9	LA	WM, I	Y	1-3	VD	M	56-65	ST
10	LA	WM, I	Y	4-6	VD, SM	F	56-65	CR
11								
12								
13								
14								
15								

Each response is coded in relation to the survey responses to minimise cluttering, whereby 'Qu1' correlates to Question 1 in Appendix B and the acronyms represent the responses given in relation to options listed under each closed-ended question. For example, for the responses to Question 1 'What is the reason for your visit today?', GD stands for General Daily Activities, LA is the acronym for 'Leisure Activity' and so on. Once finished, I was able to copy these into DisplayR and compute the first Sankey diagram. Notably, the software comes with default colours as part of the design package, hence the rainbow scheme observed in Figures 40A-C below, symbolise each category of data.

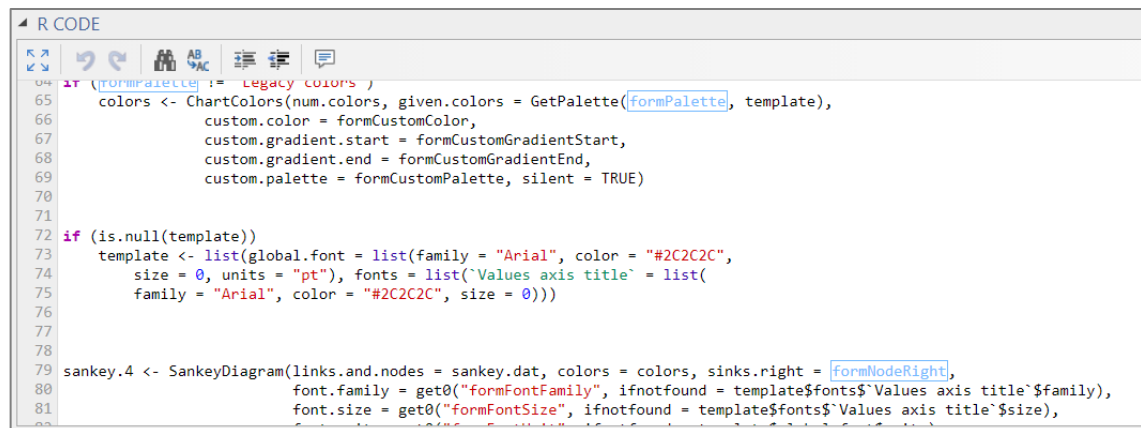
The benefit of using DisplayR and other web-based applications is that users do not need to learn specific technical skills, such as coding and 'R', as the software does this for you. However, what I did find was that there were several limitations and issues with the default settings, which required time to figure out and adjust the representations to meet the needs of the dataset and my research. The software had a threshold number of inputs that meant the total number of responses for Durham, twenty-eight, was too high and not processable by the application. I accessed the JavaScript and worked out that by changing the 'varInput' to a maximum number of outputs to 30, I would be able to present the twenty-eight responses from the Durham questionnaire collection (see line 12 below).

```

9 if (allow_control_groups)
10   form.group("DATA SOURCE");
11 var tableInput = form.dropBox({label: "Input table", types:["table", "RItem"], name: "formTable", multi : false, required: false});
12 var varInput = form.dropBox({label: "Variables", name: "formVariables", multi: true, min_inputs: 2, max_inputs: 30, required: false,
13 var pastedInput = form.dataEntry({name: "formEnteredData", label: "Paste or type table", prompt: "Opens a spreadsheet into which you
14

```

Regarding graphical formatting and finishing, the software did not ‘wrap’ text when labelling each node of response. There was no ‘tick-box’ that turned the labels off for you, so instead, I went back to DisplayR and accessed the raw R code input. I worked out which line of code related to font size and changed the size to ‘0’ which ultimately turned off the text (see lines 74 and 75 below). Once these were removed, I was able to add them manually later, by exporting the file into PowerPoint. I added the necessary labels, including each question heading, before exporting them as images into this thesis.

A screenshot of an R script editor window titled 'R CODE'. The code is as follows:

```
65 colors <- ChartColors(num.colors, given.colors = GetPalette(formPalette, template),
66 custom.color = formCustomColor,
67 custom.gradient.start = formCustomGradientStart,
68 custom.gradient.end = formCustomGradientEnd,
69 custom.palette = formCustomPalette, silent = TRUE)
70
71
72 if (is.null(template))
73   template <- list(global.font = list(family = "Arial", color = "#2C2C2C",
74 size = 0, units = "pt"), fonts = list(`Values axis title` = list(
75   family = "Arial", color = "#2C2C2C", size = 0)))
76
77
78
79 sankey.4 <- SankeyDiagram(links.and.nodes = sankey.dat, colors = colors, sinks.right = formNodeRight,
80 font.family = get0("formFontFamily", ifnotfound = template$fonts$`Values axis title`$family),
81 font.size = get0("formFontSize", ifnotfound = template$fonts$`Values axis title`$size),
```

Additionally, I found the layout of the Sankeys on DisplayR was too small and did not fill the space in relation to the display screen. This meant that when I exported the files to PowerPoint, I had to stretch the Sankey image to fit the screen better subsequently reducing the quality of the image. To fix this, I changed the layout values under properties in DisplayR so that there was minimal bordering around the illustration. I was also able to edit the gapping between each node and flow, as the software does provide chart settings for ‘appearance’ that enables you to change the node width and the spacing between each.

Inputs

Properties

Chart

GENERAL

R CODE

OUTPUT

LAYOUT

INPUTS JAVASCRIPT

Show as

Widget

Include R code

No

Show raw R output

☐

Left

0

Top

-25

Width

1040

Height

745

Hidden from exported views

☐

Inputs

Properties

Chart

APPEARANCE

Use template

Links colored by

Source

Variables share common values

☒

Node and link colors

Rainbow

Node width

15

Vertical spacing between nodes

15

off

☐

LABELS

Use default or template font settings (values axis title)

☒

Include variable in node labels

☐

Include counts in node labels

☐

Include percentages in node labels

☐

Tidy labels

☐

Label maximum length

100

HOVERTEXT

Show percentages instead of counts

☐

Once the Sankey diagrams were finalised in DisplayR, I exported these as PowerPoint files and added the necessary labels.

Figures 40A-C below present the flow of responses for the survey data collated during the first collection phase (October 2016). The first is the data graphic for Esh Winning, the second is for Stanhope, and the third Sankey is for Durham. Each graphic can present a visual representation of the participant's answers to the questionnaire, whilst also showing the range of responses and complexity between each question and provided response.

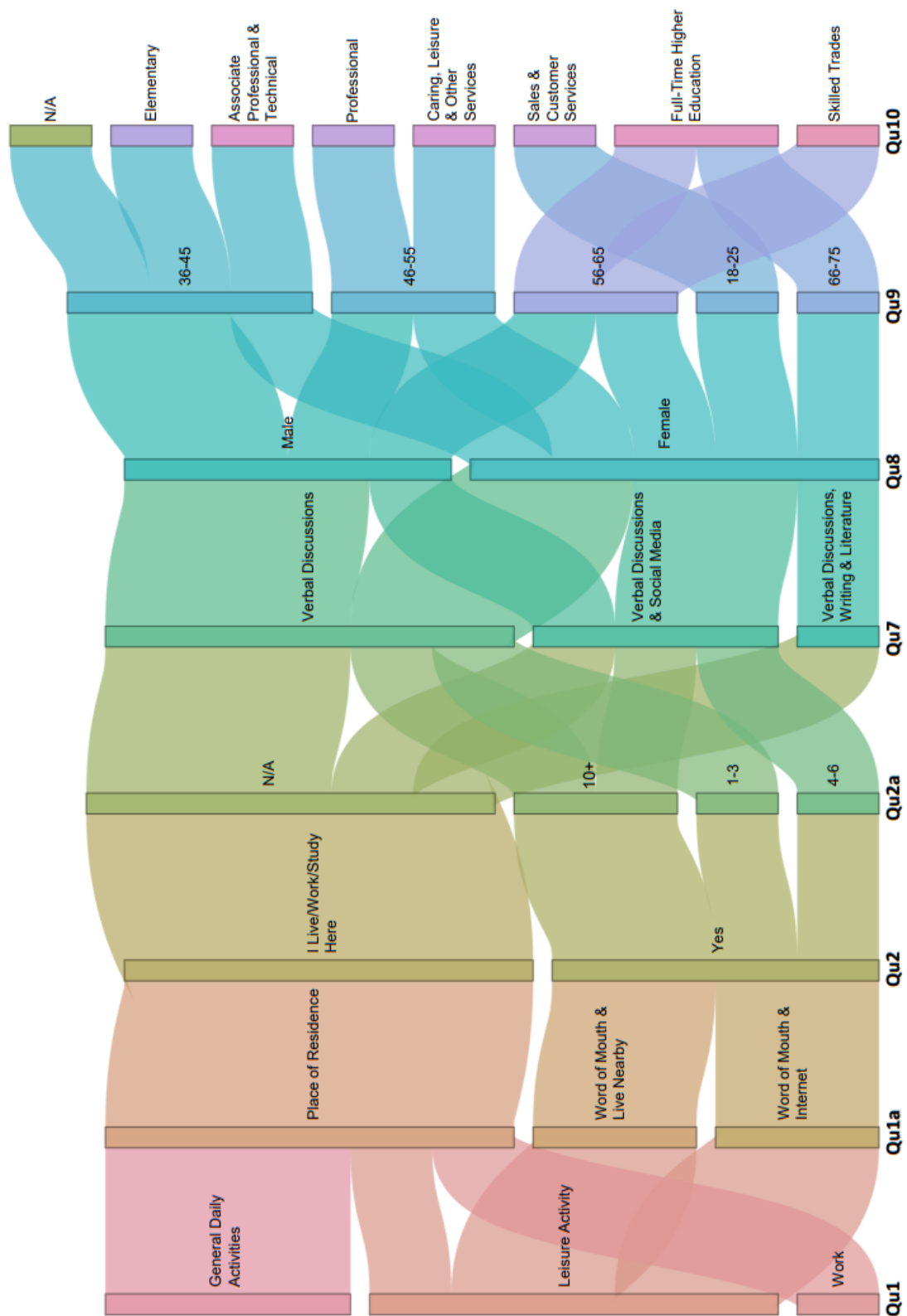


Figure 40A: Sankey Diagram: Esh Winning & the Deerness Valley Railway (October 2016)

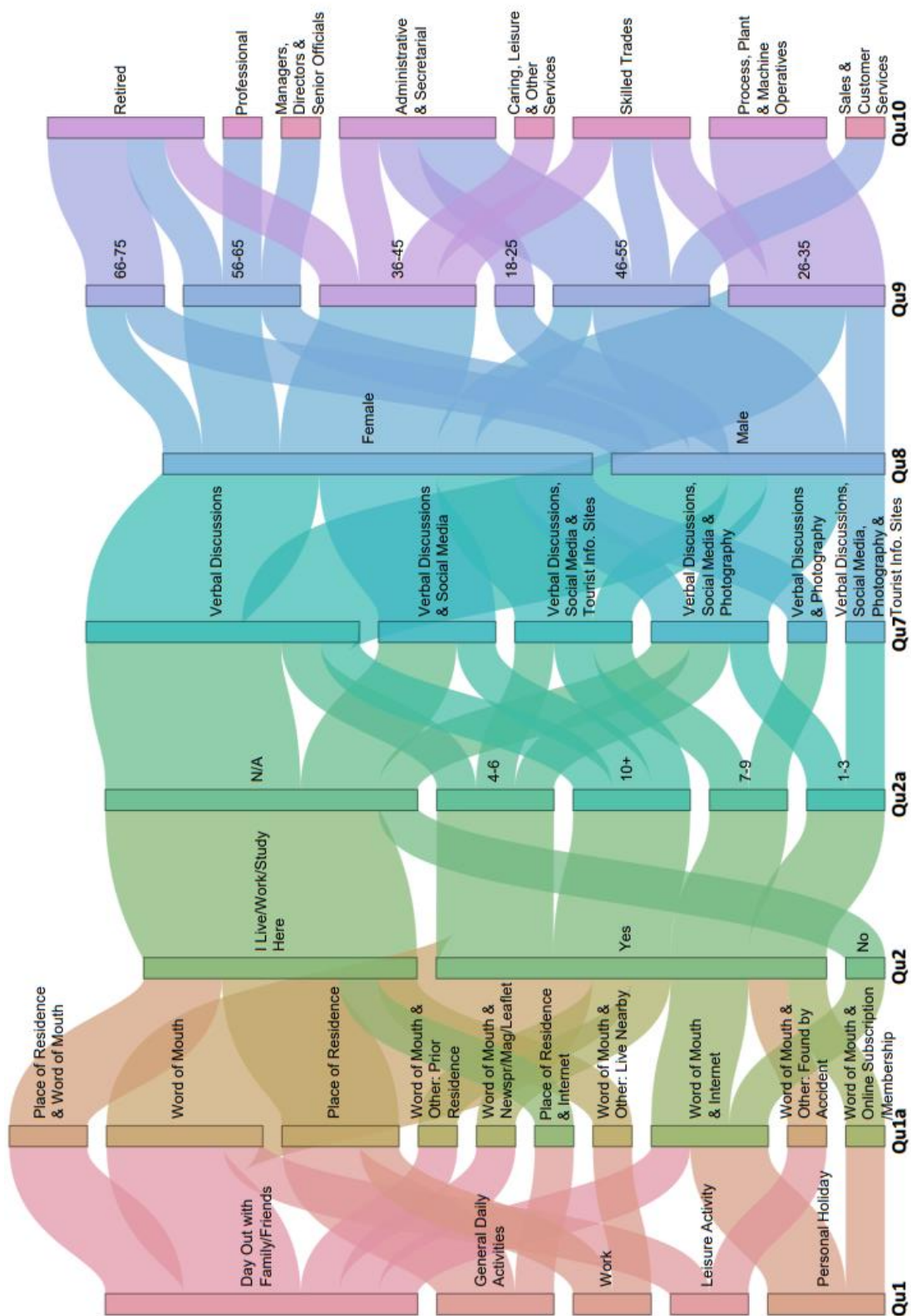


Figure 40B: Sankey Diagram: Stanhope, Durham Dales (October 2016)

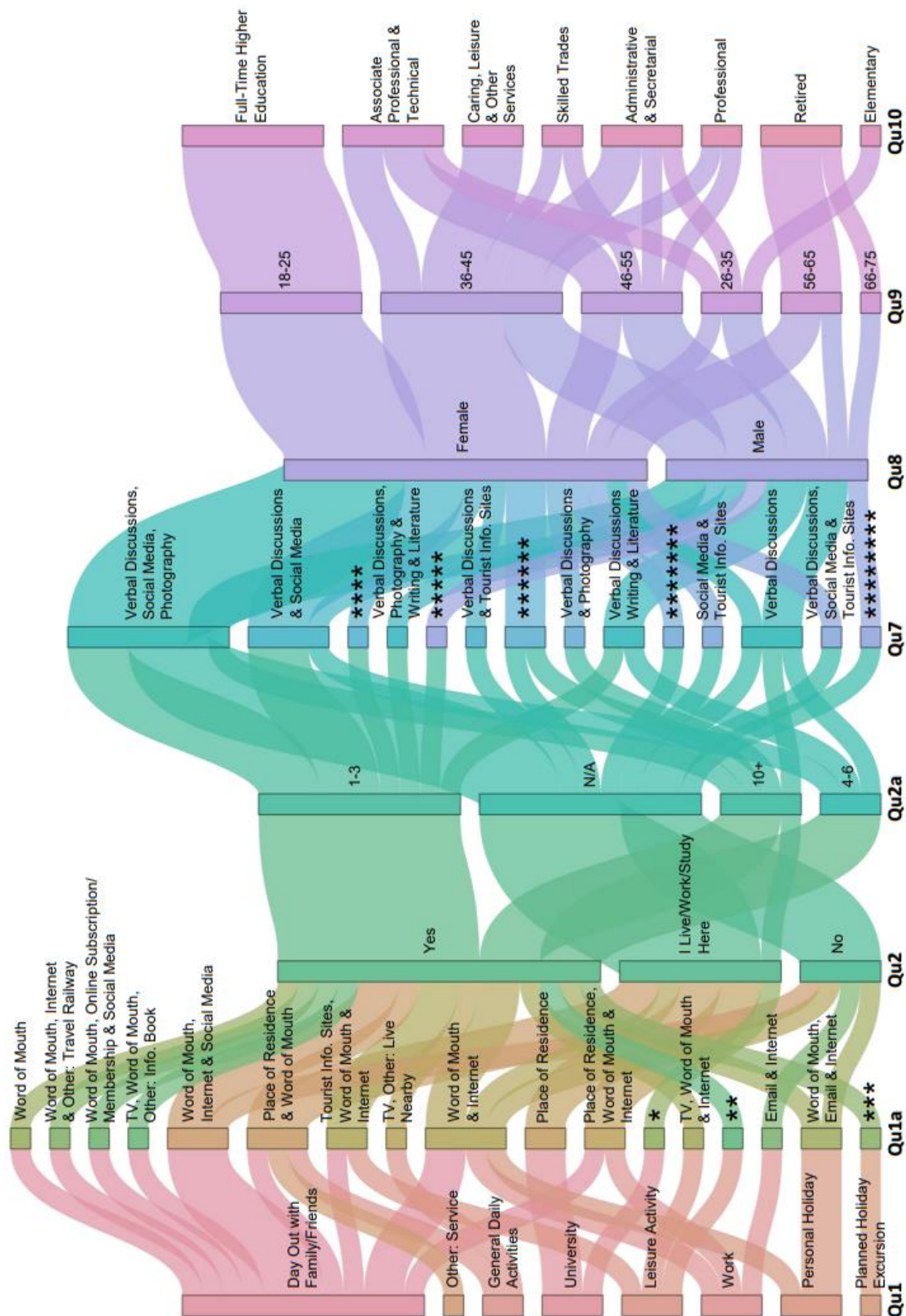


Figure 40C: Sankey Diagram: Durham City, County Durham (October 2016)

- * Place of Residence, Word of Mouth, Internet & Other: College
- ** Word of Mouth, Online Subscription/Membership, Newspaper/Mag/Leaflet & Internet
- *** Word of Mouth, Online Subscription/Membership & Internet
- **** Social Media, Photography & Tourist Information Sites
- ***** Verbal Discussions, Photography, Tourist Information Sites, Writing & Literature
- ***** Verbal Discussions, Social Media, Photography & Tourist Information Sites
- ***** Verbal Discussions, Social Media, Writing & Literature
- ***** Verbal Discussions, Social Media, Photography & Writing & Literature

Like the computational powers of GIS and the increased opportunities for users engage with web-based applications, my use of DisplayR is a literal example of where I have taken advantage of these available resources regardless of my lack of training in either JavaScript or R. DisplayR has enabled myself, as the inexperienced user, to create representations of my own using easy-to-use cloud-based applications to further my investigation in data visualisation (Kraak, 2003; Hennig, 2016). Turning to an analysis of Figure 40A, Esh Winning showcases that most of the participants were in the area for leisure and a potential reason for being that they identified themselves as residents, i.e., the mode response for question 1 is 'leisure activity' which may be justified by the number of residents identified in question 2. This later supports the 'not applicable' response for question 2a, being how often they had visited the area, as their residential status would not require a response. There were a greater number of female participants who took part in the survey, with all those aged 18-25 being female. In this graphical representation, it is easier to pick out potential patterns and relationships between the provided answers and the participants.

Observing Figure 40B for Stanhope, the predominant purpose of people's visits was to have a day-out, though the complexity of identifying whether they were a resident or not is difficult. The complication arises in the variety of answers and combination of responses for question 1a, whereby the survey asked participants to identify how they came to hear of Stanhope. Observing Appendix b, had I requested just one response, the relationship between purpose and residency may have been clearer. Additionally, in the analysis of Figure 40B, the Stanhope sample was much bigger than that of Esh Winning, hence the enhanced complexity of responses represented by a greater number of interchanging flows. As expected, the greater the number of participants meant a greater likelihood of recording a wider variety of answers and combinations of responses, such as those seen in the presented Sankey diagram. In Figure 40C for Durham, this factor is more pronounced, whereby the combinations of answers are even greater to those of Stanhope, with additional issues caused by the multiple responses requested of in questions 1a and 7.

Observing Figure 40C for Durham, the mode purpose of visit was also a 'day out with family/friends' whereby the mode response to question 2 suggests that many of these individuals had in fact visited before. In addition, having some background knowledge of Durham city, the direct link between numbers of respondents aged 18-25 and in full-time higher education suggests the survey reached several of Durham University's students. However, as noted above, this diagram is restricted further by the number of responses given

in question 1a and 7. The addition of a key to explain the relation between an asterisk and provided response means this illustration functions less effectively than the others because it requires additional time to decipher the meanings associated to the presented data. Again, this could have been rectified by limiting the number of responses requested of participants, though this issue has come to light after having completed the data collection. Instead, additional iteration would be needed to resolve these issues, by editing the data collection methods further and collecting only specific quantities of associated information.

In reflection, whilst effective, these data visualisations are still restricted by my capabilities to use specific software and web-based applications. Had I been able to produce these diagrams myself in the relevant desk-based software, it may have been possible to adjust the labelling, wrapping of text, and general layout using either JavaScript or R-code. In doing so, I would have been able to manipulate the format, potentially changed the colour scheme in line with the guidance by ColorBrewer (Harrower & Brewer, 2003; Brewer, 2003), and provide a higher quality finish. Furthermore, had the focus been on creating interactive Sankey diagrams, these issues too could have been resolved by enabling users to roll-over each category and node of flow and find out more about associated attributes. Specifically, the lack of clarity in the above Figures 40B and 40C for both Stanhope and Durham could be compensated for by removing all labels and using interactive features to provide associated information from the dataset.

Each of the figures presented fulfil their purpose to visualise the flow of responses within questionnaire data, moving from one question to the next, and assess the representation through exploratory data analysis for potential patterns and trends in the provided answers. They provide an indication of the answers provided for each question and a visual representation of quantity in relation to the width of the flow, though no specific quantities/values can be identified. Not too dissimilar to their renowned use with energy and industrial research (Schmidt, 2008, Lupton & Allwood, 2017), the above Sankeys do present the sequential and chronological answering of the questionnaire, rather than physical flow. They suggest a degree of cognition and engagement between the participant and the data collection method, by acknowledging the question, providing a response, and moving on to the next. They present a form of cognitive flow⁸⁵ being the performed action of concentrating

⁸⁵ This idea is not too dissimilar to Mihaly Csikszentmihalyi's (1975) definition of cognitive flow, including the six themes people experience when in a 'flow state'. See Csikszentmihalyi (1975, 2000) and Moneta (2018) for further details.

on the activity (i.e., answering a question), the action and awareness of doing so, the loss of self-consciousness by focusing on the task in hand, a sense of control over their actions, distortion of time taken to experience the activity (though minimal), and the experience of completing the task purely to continue it and ultimately contribute towards the research (Csikszentmihalyi, 1975, 2000; Moneta, 2018). Furthermore, like Kosara, *et al.* (2016), these diagrams also describe participant data whilst the width of the flow represents quantity, including purpose of their visit, residential status, gender, and so on. In doing so, emerging themes about the participants have appeared that may help suggest reasons for specific answers.

6.6 A Discussion

The purpose of this third and final empirical chapter has been to explore more creative, experimental methods of visualising data. I have considered the role of data graphics and their ability to present data through visually aesthetic, graphical forms, and demonstrated the marrying of data graphics and cartographic representation together as part of the visualisation. Subsequently the thesis contributes new, more innovative opportunities for exploring the relationships between people and place. Whilst I have examined a variety of spatial representations with cartography at the forefront of this thesis, I wanted to explore other alternative methods of presenting the relationships between people and place whereby each one has associated that necessary spatial quality to different degrees and extents. They are evidence to suggest that visualisation techniques can draw on the qualities and properties of other representational formats, as part of a more creative, experimental exploration of data representation (Knowles, *et al.* 2015). They highlight the importance of associating this spatial aspect, to develop methods of data visualisation that combine the motives for graphical representation with cartographic representation.

Cartographic Word Clouds present the relational dimension between groups of descriptive responses recorded in the questionnaires, associated to each DCP and surrounding landscape environment (Kirk, 2016). Doing so cartographically has incorporated the spatial quality by linking the results to each DCP, subsequently facilitating the visualisation of landscape perception. It has created more exploratory lines of enquiry by presenting the connections between perceived descriptions of place and location, and the distributions of phenomena across identified cultural heritage landscapes. I have also associated a temporal quality to the datasets by presenting and comparing results from the October 2016, February 2017, and June 2017 data collection periods. More specifically, these maps can investigate landscape as a

form of visual space, where the collection of descriptive words were prompted by immediate visual interpretations of place. These terms describe the participant's surroundings and feelings based on the physical persuasions of their surrounding environment, landscape, and corresponding aesthetic qualities (Ewing & Handy, 2009; Duncan & Duncan, 2010; Yang, *et al.* 2016). The Cartographic Word Clouds can therefore support more detailed understandings of relationships between people and place, directly associated to surrounding contexts (Jung, 2009).

Similarly, the Likert Maps allow for the visualisation of landscape themes and sense of place concepts, designed with backdrop mapping to provide the surrounding environmental context. Users can observe the spatial distribution of results such as how each landscape theme varies across each identified cultural heritage site and landscape. For example, the Likert questions designed to enquire about landscape appreciation make it possible to investigate whether responses are formulated in response to landmarks and monuments, such as Durham cathedral, Stanhope's marketplace, or Esh Winning's railway path. Additionally, these maps can also look at the strength of the relationship between the identified concept and DCPs, as the presented results relate to specific Likert scales and statements, with average responses categorised under each unique landscape theme⁸⁶. The Likert Maps have also factored in a temporal quality to the data representation, by conducting data collection at three specific time periods in a year. Though these results are not formatted one representation, a visual side-by-side analysis enables users to compare each temporal map alongside one another. The Likert Maps are the visual products of my devised methodological tools, designed to quantify qualitative data and communicate findings through aspects of symbology (Aitken & Kwan, 2010; Harvey & Aultman-Hall, 2016).

Regarding the usability testing, the Likert Maps vary in functionality depending on their design. The maps which included more effective designs (i.e., the pie charts and grid-like maps) were better received and functioned well and communicated the data findings effectively. The radar charts, however, were less well-received and these were found to be difficult to navigate and to draw out the meanings from the representation. They required additional time to decipher the underlying narrative and functioned less as an at-a-glance illustration. Whilst Cartographic Word Clouds can visually communicate the mode response more efficiently, the Likert Maps need various map legends and context to support the

⁸⁶ See Appendix B, questions 4, 5, and 6

presented findings. They both however, link back to Lynch's (1960) idea of a collective image, where participants have subconsciously identified a point within their surroundings, prompting the relation between themselves and the image/object and/or setting. The representation presents these connections and ties to place, enabling users to interpret and question the accumulation of narratives between the perceptions and the perceived environment. As a collective, these cartographic representations of observations and personal interpretations provide the additional depth and meaning to understand the more intangible aspects of cultural heritage landscapes, and how these experiences have contributed towards the imageability of the physical environment (Lynch, 1960).

Additionally, it was interesting to see how the Likert innovations were received by participants and their thoughts on each genre of map: the Likert Pie Chart, Likert Grid and Likert Radar maps. The level of familiarity with the data graphics included in the design of the map may have persuaded participant engagement and supported their understanding (i.e., pie charts), whereas the improved Likert Grids received increased recognition of their innovation. However, surprisingly, it was interesting to see that the cartographic preferences of the participants were not reflected in the overall aggregated scores from each part of the test.

The Sankey diagrams on the other hand, did not rely on geographical referenced data hence their primary function as a form of data graphic. They were designed to visualise the flow of responses within collated survey data, using exploratory data analysis techniques to decipher any patterns, trends, and anomalies in the associated dataset. They enabled me, as the user, to visualise the magnitude of responses but also the links between each category of question. The resulting representations can fuel further investigation, but a spatial quality can only be loosely applied as a data category/variable. Having tabulated the data in excel and sourced a web-based application for producing these diagrams digitally, my use of DisplayR became a key example of users taking advantage of available online resources to further investigations and create effective data visualisation (Kraak, 2003; Hennig, 2016). I was able to navigate the application, input my data and make clear and simple selections based on the type of graphic I wanted, its format and style. However, I did find limitations with the default settings engrained with the programme that required additional time to figure out and adjust the representations to meet the needs of the dataset and my research. The Sankey diagrams, however, do present the sequential and chronological answering of the questionnaire, rather than physical flow. I argue that they present a form of cognitive flow about the participants

and their engagement with identified landscapes, through the performed action of completing the research survey (Csikszentmihalyi, 1975, 2000; Kosara, *et al.* 2016; Moneta, 2018).

Referring more towards the design constraints of each, the Cartographic Word Clouds are not without limitations or issues, ranging from the size of the NVIVO word cloud to the presented quantities of responses and representability. They contain evidence of cartographic clutter, due to the layering of information on top of the basemap, though they do still function as supplementary forms of visualisation. Specifically, for accessibility the word clouds are not placed on top of each DCP point because this would hinder access to the spatial context, specifically the surrounding environment and landscape presented through the satellite image. The Likert Maps suffer similar issues regarding accessibility, though I have placed the clusters of coloured squares on top of the DCP points, relating to where the data was collected. These allow for more accurate visual analysis of the distributions of phenomena, though again they require the further context to understand what each square represents, and the corresponding colour symbology. The usability testing of the map innovations also revealed that out of the maps tested, the Likert Pie Chart (2) received the highest average scores suggesting this representation was the most effective and well-met. The preference, however, was to use either Likert Pie Chart (1) and Likert Grid (1) to present attachment to place data subsequently being of effective map design, having a clear legend and suitable symbology and representational techniques.

These restrictions and constraints are subsequently down to the discretion of the designer, to determine how best to approach the data collection and data representation design. I needed to determine a perceived usefulness and make sure that all my produced data visualisations could meet the aims and objectives of the project and communicate the purpose and motive of the representation design. However, there is a growing reliance on computational and technological power to create more functional and accurate representations. This research utilised GIS as a technological tool because it is was able to accommodate and facilitate research needs, furthering the integration and digitisation of qualitative data into computational formats (Yeager & Steiger, 2013; Pavlovskaya, 2018). Specifically, I have done so in two ways. Firstly, by producing various descriptive statistics that would allow me to symbolise information through various colours, shapes, symbols and displays. Secondly, I allocated numerical representations to categories of information, where these numbers are not representative of value but are used to allocate symbols and provide some form of visual access to complex datasets. In this research, either process was dependant on the purpose of

the data representation. The Cartographic Word Clouds were primarily a data graphic placed atop a basemap, to communicate the range and mode of responses quickly with minimal reliance on numerical validity. The Likert Maps associated each average response to a colour ramp, regarding the one-five scale, using various symbology techniques to visualise perceptions by DCP. The Sankeys aggregated the surveys to each research location to enable users to observe categories of responses and decipher quantity through the width of each node and link. It is not possible to visualise one participant's responses or associate the findings to a specific location around the research site. In addition, though these are digitally created, there are still design issues and constraints which limit their functionality that I assume are fixable/preventable had I been able to use computer-based software to create the diagrams.

I have also highlighted a reliance on integrating various degrees of a spatial quality as part of the approach to design more creative data visualisations. Users need to understand the scale of the project to consider how best to present and communicate information clearly, from the size of the research locations and distribution of DCPs, to the aggregation of results for various manipulation and transformative purposes. A macroscale project would require the necessary aggregation of results, with the risk that over-generalising the data will hide detailed patterns and correlations. A microscale project on the other hand, like this one, do the opposite and may exaggerate and exemplify records, whereby results may appear to show homogenous significance and meaning across the spatial distribution.

The colour symbology is an ongoing debate that cartographers and graphic designers alike must engage with. Specifically, colour hues were pinpointed in the Likert symbology to make sure the classifications were distinct and unique to the representation of identified values. The neutral association of the colour blue was strategically done to remove any metaphorical and symbolical representations that may mislead the interpretation of results (Kovesi, 2015; Junhua & Jing, 2012; Robinson, *et al.* 1995). However, it appeared that the Pie Chart innovations and their use of red, yellow, and green in relation to Likert categories, was indeed effective and supported the interpretation of information within the map. The Sankey diagrams used predefined colour schemes to distinguish each category of data and are not representative of magnitude or scale (Monmonier, 1996). Each category related to a question with these listed vertically, and each node was a response given as part of the closed-ended question types in the survey. Each section was allocated a colour to differentiate between the neighbouring segments. Again, these too contained issues of clutter though a compromise is required to balance the communication of results with the required contexts. This was evident

in the Cartographic Word Clouds, whereby it was difficult to determine whether each word cloud needed to provide accessible information relating to the range of responses or provide a visual indication of the mode in relation to the underlying spatial context. For this thesis, the map needed to present the most frequently used term in relation to specific geographical points, therefore clear communication of the mode response was required. The result, the Cartographic Word Clouds can present people's opinions of place in relation to the corresponding perceived environment.

I have found that to combine data graphics with cartography effectively, it is a fine balance between artistic representations and creativity, and the validity of the sources to communicate reliable results. Associating a spatial quality requires quantification and the calculation of various numerical descriptives to run complex datasets through required software, but in some cases these values are not representative of quantity or value. These numerical values are calculated to digitise information and associate corresponding colour symbology. Furthermore, examining these data visualisations has increased my awareness of access to visual content, regarding the complexity of cartographic design. Cartographic Word Clouds and Sankey Diagrams are more suited to quick and effective visual analyses whilst the Likert Maps require time to decipher and understand the story about the various landscape themes and sense of place concepts. Additionally, the formatting of data representations is an integral part of the process. To reduce the risk of confusion and/or ineffective knowledge communication, side-by-side analysis provides users with clearer access to the presented information, to make comparisons regarding spatial/temporal dimensions (Bimrah, *et al.* 2010). This visual interrogation allows users to both explore and supplement their research by looking at the relationships between people and place in more creative ways, with the potential to fuel further investigations and lines of enquiry.

The focus on people's experiences with cultural heritage sites relates back to the thesis' objectives, to consider how data visualisation and cartographic methods can be developed, innovated, and deployed with heritage research. Each data visualisation consequently engages with Wylie's (2007) conceptualisation of landscape, to enable users to decipher the physical and material markers that prompt responses to landscape. In this investigation, symbolic landscapes have provided key evidence to understand the formation of landscape perception, by considering the various points and markers that are embedded within the fabric and immaterial qualities of landscape (Wylie, 2007). Specifically, perceived landscape identity is based on a collection of personal and social constructs, referring to more than the physical

representations that often characterise place (Stobbelaar & Pedroli, 2011). I have recorded and collected this detail to visualise and identify how environments may persuade response, through the spatialisation and representation of data in cartographic form (Skupin & Rossetti, *et al.* 2019; Crampton, 2013; Fabrikant, 2003). I reiterate my previous argument⁸⁷ that landscape is more than just an object of perception. These maps can reveal aspects of the landscape veil made up of subjective, intangible detail (Wylie, 2007), constructed in response to the historical importance and cultural significance embedded within areas like Durham, Stanhope and Esh Winning. This thesis has taken the metaphorical layers of qualitative detail, quantified it, and transformed these into digital formats for processing and visualisation. Thus, whilst these maps are exploratory in type, they can be used to observe the complex patterns and relationships between people and place with additional context. Researchers can use these maps and other forms of data visualisation to selectively depict themes of landscape experiences, such as the five sense of place components, to better understand the connections between people and place (Yang, *et al.* 2016; Soini, *et al.* 2012).

To conclude, each of the three representations explored in this chapter encompass a level of creativity through their design and formatting. They can communicate and deliver knowledge through new forms of visual interrogation and associate a spatial quality within their subsequent design strategies. The representational form is dependent on the desired function of each, whilst the integration of the spatial quality is facilitated by an effective collection strategy and methodology. It has not restricted the ability to tell stories with data, as it has provided an alternative lens for the narratives to be told (Kirk, 2016; Yau, 2011). The Cartographic Word Clouds, Likert Maps, and Sankey Diagrams have provided visual examples to explore, present and express meanings from within complex datasets, relating to the relationships between people and place. They can contribute towards the creation of exploratory and supplementary research tools, with the potential to prompt further investigation by communicating new geographical knowledges.

⁸⁷ See Chapter 2.0, section 2.4.2 The Landscape Veil.

Chapter 7.0 Conclusion

7.1 To Conclude...

This chapter contains a summary of the results presented in relation to each identified research question (section 7.2), to highlight how each of these queries have been met and the research aim achieved. It will also consider key reflections and considerations in completion of this research (section 7.3) and outline the potential future research avenues that stem from the findings.

7.2 The Research Findings & Contributions

This thesis has encompassed the theoretical frameworks and conceptualisations associated to GIS, data visualisation and landscape. I have used heritage geographies and aspects of landscape research as the empirical focus, to frame the research and facilitate the aim to critically assess the capabilities of data visualisation as a medium for effectively presenting and communicating qualitative data. The following section will articulate the research findings and contributions in relation to each identified research question.

7.2.1 Strategies and Techniques for Qualitative Cartography

What strategies and techniques can be deployed to integrate the quantitative and qualitative, to create more qualitative forms of cartography that reveal the connections and complexities between people and heritage sites?

The thesis has an overarching contribution to provide a means for interrogating complex, primarily qualitative, datasets through a critical engagement between qualitative research and GIS. With a focus on cultural heritage landscapes, this consideration has enabled the development of tools and techniques that can quantify qualitative information and transform it into visual forms. The consequent representations facilitate an exploratory analysis, fuel further investigations, and supplement the creation of new geographical knowledges. Using data visualisations in such ways can provide an alternative lens for observing social geographical phenomena, to see the narrative emerging from datasets and between specific categories, groups, and themes of data (Yau, 2011; Kirk, 2016). Through GIS, I have experimented with various methods for quantifying qualitative data and engaged with capabilities of various technologies for visualisations, to facilitate discovery and help social scientists acquire more meaningful understandings of the relationship between people and place.

Having considered both cartographic representations and data graphics as part of a data visualisation package, the thesis has showcased several examples where these enable users to make sense of data through associated tools and techniques, either as independent chart types or by combining data graphics with cartographic representation (Yau, 2011; Lee, *et al.* 2015; Kirk, 2016). Chapter 2.0 explored the history of mapping and cartography in relation to this thesis highlighting key developments and contributions that underpin the familiar data graphics and cartographic representations observed today. Robinson's (1952) argument that 'form dictates function' prompted further understanding of the interrelationship between design principles and cartographic representations to facilitate map logic and map language and the role of the user, relating specifically to aspects of the communication model and a need for effective map design (Koláčný, 1969; MacEachren, 1995; Crampton, 2001). The association of psychological theories and research have enabled researchers to focus further on visual perception and cognition, helping cartographers and researchers alike better understand how a design/form can enforce functional map use. This includes the use of graphical marks (i.e., map symbols) and colour choices.

The transition of cartography into the digital world has also showcased the debates surrounding the shift from professional origins to one where anybody with access to a computer and GIS can create a digital map. Whilst the increase in technology has opened access to GIS systems and other easy-to-use mapping tools and software, it has done so without the associated methods and principles needed to produce effective forms of cartography (Kraak, 2003). Like my own example of using DisplayR, software often lacks elements of good cartographic practice for creating effective, innovative mapping approaches and visualisations, however I do acknowledge that the widening availability and creation of new tools and techniques has further an engagement with digital cartography and the geographical field more widely (Hennig, 2016). Subsequently, the introduction of GIScience as a multidisciplinary field has prompted researchers to consider GIS as more than just a tool but a means for making sense of geospatial data and presenting geographical information (Slocum, *et al.* 2008; Cartwright, 2011). Subsequently, the strategies and techniques deployed in this thesis are centred around maps as more than just a form of representation or aesthetic creation, they are a form of visual communication that can facilitate further thought and exploration.

Qualitative GIS has been a key integrative, mixed-methods approach for combining information visualization and spatialization with qualitative semantics, because it can facilitate more meaningful interpretative analysis and do more than just function without the numbers (Kitchin & Dodge, 2007; Elwood, 2010; Kitchin, *et al.* 2013). It associates the implementation of data collection, analytical, and representational processes, each of which facilitate a more in-depth understanding of social, geographic phenomenon across space. Grounded visualisation has also underpinned this thesis because it can be used a tool for exploring the relationships and connections between people and place. By integrating GIS to represent and analyse qualitative data, it can facilitate the creation of new data representations and help users to explore sociospatial data by enabling individuals to observe perceptions in relation to identified locations, patterns of behaviours across geographic areas, and the potential links between human agency and the environment. Together, both qualitative GIS and grounded visualisation can facilitate the combining of qualitative data with quantitative spatial information, to provide more meaningful, more in-depth considerations of the complex relationship between people and place (Seegers & Giordano, 2015; Franke, *et al.* 2017).

From a methodological perspective, this research has been able to devise a methodology that can capture the interpretations and perceptions of individuals within specific heritage settings, to create more qualitative forms of cartography. Specifically, this has included the devising the audit surveys which have a key capability as a data collection tool to record observations from within specific, pre-determined environments about peoples' behaviours and responses to various landscapes (Brownson, *et al.* 2013; Day, *et al.* 2005; Day, *et al.* 2006). Using the conceptual framework of perception and a tripartite understanding of landscape (Wylie, 2007; Ewing & Handy, 2009), Appendix A is also a methodological contribution, being a newly devised audit suitable for a range of research settings and environments. It is the result of a tailor-made design derived from pre-existing examples, that has contributed a rubric capable of assessing rural to urban landscapes, recording categories of detail that can support an examination of landscape perception. Though they are of a more experimental dimension audits enable not only the data processing for analysis and representation, but also the initial sorting and categorising of raw data into relevant themes and categories prior to the collection process (Cihlar & Jansen, 2001; Southworth, 2003; Harvey & Aultman-Hall, 2016). They are an effective, quantifiable tool for collating information to supplement other forms of data collection and resulting cartographic representations.

Questionnaires were also a key data collection method used to classify data, record details about participants' behaviours, and to describe the attitudes and opinions of participants, referring specifically to the perceptions and interpretations that participants formulate as a response to having visited certain sites. In Appendix B, the use of strategic and systematic formatting ensured I was able to collate qualitative detail in quantifiable ways, but also ensure I could collect the necessary details and description to support the records and findings. More specifically, the Likert Scales are a key example of how to collect qualitative information in a quantitative manner, as they can collect information about participant's attitudes and perceptions by grouping statements in relation to sense of place themes. Using descriptive statistical analysis, researchers can calculate an average value of responses for each Likert statement and use these numerical figures in the representation of data. In addition, the final primary data collection method, semi-structured interviews, used the questionnaire as a guide and a series of questions relating to specific topics to provide direction, though the questions were open-ended for additional details (Punch, 2005; Bryman, 2016). I was able to record details about their visit, experiences, reasons for their presence, but also enquire further about the reasons for their answers and acquire additional details and context. Once transcribed, this detail was then suitable for further discourse analysis and exploratory spatial analysis, by integrating GIS with other computational software as seen in Chapter 6.0. The use of audit surveys, questionnaires and interviews methods have facilitated the production of new geographical knowledges through data visualisation (Elwood & Cope, 2009; Aitken & Kwan, 2010), enabling my work to contribute to a wider body of research.

By engaging with these elements amongst others noted in this thesis, a critical awareness of the capabilities of data visualisation and the purpose and power of mapping has fed into the construction of more qualitative cartographies. I argue that data visualisations can be more than just a method of representation, a vehicle of communication (Kent, 2018) or a visual system of correspondence (Wilson, 2017), they are part of a processual science and always under construction (Kitchin & Dodge, 2007; Kitchin, *et al.* 2013). They are consistently made and re-made with every user's intention to decipher and interpret the message within the representation whereby the user brings in their own positionality and experience to the process (MacEachren, 2004; Del Casino & Hannah, 2006).

7.2.2 Data Visualisation and Cartographic Innovations

How can data visualisation and cartographic methods be innovated and adapted for heritage research, to represent the subjective and intangible factors and provide a form of knowledge communication?

Qualitative data visualisations can acknowledge and include a spatial quality as part of an ensemble or research recipe, dependable on the desired design specification and dataset. More familiar graphical forms of representation can do so through the categorisation and aggregation of data into spatially defined themes (i.e., countries, regions, postcode), though there is not always a need to. Regarding cartographic creations, these need to have the spatial dimension pinpointed thoroughly from the initiation of a research strategy, to the production and analysis of specific cartographic representations. Within human geography, effective qualitative GIS and subsequent cartographies can be used to produce new knowledges and reveal the various spatial contexts from complex social relations (Elwood & Cope, 2009; Boschmann & Cubbon, 2014). Regarding cultural heritage landscapes more specifically, these relationships can be represented to initiate the storytelling of data narratives (Yau, 2011), and analysed through modes of analysis such as grounded visualisation; using these representations to acquire more detail and further context as supplementary sources. In so doing, geographers can develop a more in-depth understanding of various topics and themes, such as landscape perception and the subjective landscape veil (Wylie 2007), to reveal the meanings from both the data and intangible contexts and fuel further lines of geographical enquiry (Aitken & Craine, 2009). Consequently, qualitative GIS and qualitative cartographies can produce and contribute new forms of spatial knowledge, where quantitative data alone cannot (Yeager & Steiger, 2013).

In Chapter 4.0, the examination of land use maps as a form of categorical mapping prompted explorations into the categorisation and representation of qualitative data. As an exploratory tool, land use maps are useful in many areas of research, including landscape and heritage, as they can provide the background context and backdrop mapping to provide further context about investigated phenomena, to explain and suggest reasons for the occurrence. Notably used within areas of heritage management and environmental risk assessment, LU maps are key for understanding change and highlighting areas of importance/significance, understanding the link between human activity and landscape (Yu, *et al.* 2016). By identifying features and describing their purpose, these maps can supplement and contribute towards an interpretation of landscape and facilitate understandings of the relationships

between the physical environment, people, and place. Furthermore, the audit maps, though in their first representational forms, can be used as graphical expressions for visualising spatial distribution and providing complimentary information for analysis (Serra-Coch, *et al.* 2018). They enable users to discern various patterns, trends, anomalies, and outliers within their datasets alongside the environments in which they were collected. In relation heritage research more specifically, they can enable researchers to understand diverse layers of complex systems that may offer explanations for the interactions and behaviours seen in various landscapes and settings. These maps are a starting point for investigating the relationships between people and as a supplementary tool, alongside further context they can be used to prompt and further geographical enquiries.

Chapter 5.0 focused on the capabilities of choropleth and flow maps as exploratory research tools to provide incentive and prompt further investigations about social, spatial, geographic phenomena. The purpose of the choropleth maps was to represent the spatial distribution of participants who were present within each research location and consider the distance travelled to visit, as well as why. For heritage research and heritage organisations, this can be useful to see the reach of the heritage management projects and conservation efforts, especially those areas who advertise their landscapes to an audience as a means for raising awareness of the cultural significance and historical importance associated of identified location. In addition, the flow maps or Postcode Plots took this a step by calculating and representing the distance travelled from identified postcode areas (Smits, 1999; Phan, *et al.* 2005; Jenny, *et al.* 2016). They were designed to show the movement of visitors from their areas of residence to specific cultural, heritage sites, providing a clear picture of the distances travelled. Both maps focus on representing data associated to the participants specifically, providing an additional means for understanding the relationships with landscape and various cultural heritage sites. By finding out more about the people within various landscape, it is possible to delve further into the complexities between people and place. Using these alongside other maps in this thesis, users can discern more about the landscape and consider the how and why queries of an investigation (Brown, *et al.* 2015).

In Chapter 6.0, each data visualisation was able to engage with Wylie's (2007) conceptualisation of landscape, considering the responses and perceptions recorded about each cultural heritage landscape. I was able to record a collection of personal and social constructs (Stobbelaar & Pedrolí, 2011) and consider how environments may persuade response, through the spatialisation and representation of data in cartographic form (Skupin &

Rossetti, et al. 2019; Crampton, 2013; Fabrikant, 2003). Specifically, the combining of NVIVO and GIS in this thesis has offered another visual approach to the representation of subjective and intangible detail (Aitken & Kwan, 2010). By combining both software, NVIVO has enabled the content analysis of collated datasets and the production of associated data graphics whilst GIS was able to present these representations in relation to spatial context. By linking the word clouds to an underlying basemap and using the DCPs as geographically referenced points, it was possible to visualise the spatial distribution of people's perceptions based on the descriptive words collected in the questionnaire. However, whilst these maps can present participant's responses and opinions about each of the heritage sites, the results themselves are not entirely transparent nor flawless. Due to several issues noted in the construction of the Cartographic Word Clouds, they can only provide an indication of patterns and trends and are not a replacement for more detailed, more careful analysis (DePaolo & Wilkinson, 2014).

The Likert Maps also make use of the questionnaire to collate responses through Likert scales. They enable the visualisation of landscape perception by collecting evidence of sense of place themes, associated to the metaphorical layers of qualitative detail that individuals associate to various landscapes. The maps provide a visual means for observing potential relationships between people and place through exploratory spatial analysis and enquire about landscape appreciation perception. The maps make it possible to investigate whether interpretations are formulated in response to landmarks and monuments, such as Durham cathedral, Stanhope's marketplace, or Esh Winning's railway path. However, the varying functionality of the maps was evident in the evaluation of their design, being the data collected during the Map Usability Project. The usability testing was a useful exercise to see how these innovations were received and discuss the suggestions for their improvement, however more suitable testing with heritage researchers and/or experts is required to develop these into more effective cartographies of heritage.

The Sankey diagrams, though they did not rely on geographically referenced data, were able to describe the participants who contributed to the study through the questionnaire. In doing so, heritage users can use these flows of responses to visualise characteristics of their data such as descriptions about the sample population, but also the links between each category of question. They enable researchers and other users alike to consider the responses given and explore the relationships between categories of responses (Kosara, *et al.* 2016). For example, this may refer to the purpose of their visit, residential status, gender, and so on. In doing so,

emerging themes about the participants can appear to explain reasons for specific answers. The Sankey diagrams also present a form of cognitive flow about the participants and their engagement with identified landscapes through the performed action of completing the research survey, though further work is needed to expand this potential further (Csikszentmihalyi, 1975, 2000; Kosara, et al. 2016; Moneta, 2018). Subsequently, within heritage research, these maps and other combinations of data graphics and cartographic representations can selectively depict themes of landscape experiences to better understand the connections between people and place (Yang, *et al.* 2016; Soini, *et al.* 2012).

Landscape is an object, a form of representation, and a process of persuasion whereby it is a vernacular for investigating perception (Wylie, 2007). Whether as a text or image that individuals observe to decipher the layers with the metaphorical veil, an interpretative view is required to draw out these meanings and record the responses and behaviours within identified landscapes (Wylie, 2007). With this information, it is possible to turn this into new knowledges by associating more creative forms of data representations and associated analytical techniques. Consequently, maps as a form of cartographic representation can be used as part of a data visualisation package, either as unique standalone innovations or as complimentary and supplementary methods of visualisation. Data graphics and cartographic representations can be used alongside or in tandem to one another by blurring the lines between each to create new innovative forms of data visualisation, for interrogating and deciphering the complexities between people and place.

7.3 Research Reflections and Future Directions

7.3.1 Reflections and Considerations

Though the focus of this thesis has been to consider how data visualisation can be used to explore landscape, integrating GIS to represent and analyse qualitative data, there has been an underlying engagement with research methodologies to facilitate this process. This thesis has identified limitations regarding the lack of methods and guidelines available to quantify qualitative data. Though I have used software (i.e., NVIVO) to categorise and quantify evidence into various geographical themes, there are few methods capable of doing so from the initiation of the method. Like the urban-based audit surveys, some existing methods cannot be directly replicated into other's research. They require lengthy development through sequential drafting, piloting, editing, and redrafting to devise applicable collection methods. However, I propose that researchers can make use of more creative and innovation techniques to collate required datasets, using integrative approaches (i.e., qualitative GIS and grounded

visualisation) and visualisation techniques to decipher the complexities within their datasets. As observed in this thesis and the findings above, it is possible to collate necessary data and tell more meaningful stories by engaging with data collection, manipulation, and representation processes. Hence, I believe that it is necessary to acknowledge newer techniques for visualising data to devise and develop more creative and innovative forms of data representation.

Furthermore, the study could explore and utilise methods for more effective data digitisation compatible with computers and various software. Rather than the time-consuming process of manipulating paper-based methods into digital formats, further research could investigate the development of technologies that can record information in-situ (see Kwan, 2004; Šveda & Madajová, 2015), such as handheld computers and various technological applications (i.e., a mobile app). Doing so would facilitate more effective data handling, manipulation, and transformation, and provide opportunities to explore other geographical avenues, including critically assessing landscape engagement and experience using technological devices to track visitors' journeys around cultural heritage sites and tourist attractions. Unfortunately, there are still issues regarding the loss of rich detail and description caused by processes of quantification, digitisation, aggregation, and categorisation. I am aware that numbers cannot offer the description and details that the original, untouched records can (Kirby, 2003; Aitken & Kwan, 2010), however implementing these resources selectively, the data can contribute and supplement the collated database as part of an integrative, more innovative mixed methodology.

7.3.2 Future Research

From my conclusions, this thesis opens avenues for future research directions that I feel are worthy of investigation. Firstly, incorporating other primary datasets into the research investigation can further utilise and test the qualitative GIS approach, and create additional qualitative cartographies. Participatory methods through participant-generated visual methodologies (see Guillemin & Drew, 2010) would be a useful tool regarding interpretations of various landscapes, environments, and journeys. Considering sketch maps (Boschmann & Cubbon, 2014), providing blank OS maps for participants to draw on and fill in could be digitised onto other OS backdrop maps to compare landscape perceptions. Providing blank pieces of paper would give participant's freedom to draw their own representations, whilst compiled together would produce a variety of narratives from their landscape experience. Photographs could be collected and scrutinised through a content analysis, to identify specific

tourist hotspots at cultural heritage sites and/or tourist attractions. These could be used to create photographic density maps and observe which landscape features, markers and monuments are most photographed by visitors and why. Furthermore, diary accounts from participants over a specific period could be used to collate experiences about visits to identified cultural heritage sites, to investigate the development of perception. Factors which may influence and contribute towards various perceptions could be pinpointed as evidence of themes including sense of place and attachment. This material could then be represented in similar ways to Cooper & Gregory (2011), using density maps to plot emotions and various humanistic concepts, and visualise place name/landmark frequency.

Further usability testing would enable more rigorous testing of qualitative cartographies, specifically making use of other technologies to strengthen their design and in a cartographic sense, better understand the relationship between the map, map user and map creator (Harrower & Fabrikant, 2008; Wilson, 2017; Griffin, 2017). More specifically, eye-tracking technologies could be deployed to develop representations further, especially regarding the integration of GIS and the analysis of qualitative data. Web-based platforms and other technologies can help establish not only the functionality and effectiveness of the representation, but also explore the cognitive processes that enable users to engage with maps and their readability. This could also expand to data graphics too, considering the principles and techniques that were established and contested many years ago (Bertin, 1967; Wood, 1968; Tukey & Wilk, 1970; Tufte, 1983; Robinson, *et al.* 1995; Bertin & Berg, 2010).

Regarding wider geographical contexts, my methodologies, approaches and analytical techniques could be used to support other lines of enquiries. Previously referred to in Chapter 2.0⁸⁸ regarding critical GIS, feminist geographers argue that primary data collection techniques can be integrated with GIS to explore the ‘spatial stories’ about society (Kwan, 2002a:653). Specifically, the qualitative GIS approach used in this thesis has the potential to contribute to other investigations, providing the guidelines to effectively integrate qualitative data with quantitative processes and successfully implement a spatial quality to visualise this information. Researchers can create visualisations capable of presenting the experiences of women within their daily lives (Kwan, 2002a; Kwan, 2002b), observing the connections and relations between people and place, whilst drawing on collated detail and description to supplement discovery and produce new knowledges. Techniques established in this thesis

⁸⁸ See Chapter 2.0, section 2.2.1 Critical GIS

may be used to enrich existing approaches in exploring and presenting women's experiences with the built environment. Additionally, the methodologies and qualitative GIS approach allows researchers to consider a more conceptualised GIS and its role within feminist geographies and gender studies; specifically, the innovations of GIS to contribute towards more feminist visualisations, their use as a research tool, and the inclusive nature of the technology to strengthen social theorisation (see McLafferty, 2005; Pavlovskaya, 2009b; Leszczynski & Elwood, 2015).

Chapter 8.0 Bibliography

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Chapter 9.0 Appendices

Appendix A- Audit Survey

Date: _____ Start Time: _____ Finish Time: _____ Auditor: _____
Place: _____ Street Name/Location: _____ Segment ID: _____
Grid Reference: _____

Audit Information Collected By: Foot ☐ Auto ☐ Both ☐
Location Information Collected By: Foot ☐ Auto ☐ Both ☐

WEATHER

1) Within the segment, what are the current weather conditions?

Sunshine	☐	Thunder	☐
Clear Skies	☐	Lightening	☐
Partly Cloudy	☐	Storm	☐
Overcast/Cloudy	☐	Gentle Breeze	☐
Fog	☐	Strong Breeze	☐
Frost	☐	Windy	☐
Rain- 'Spitting'/Light	☐	Warm	☐
Rain- Heavy	☐	Hot	☐
Flood	☐	Cool	☐
Hail	☐	Cold	☐
Sleet	☐	Freezing	☐
Snow	☐	Other:	☐

AREA IDENTIFICATION

2) Are there signs, monuments, or markers to indicate entry to the neighbourhood/specific district or area? (i.e., 'Welcome to... Housing Estate names)

Yes ☐
No ☐

STREET CHARACTERISTICS

3) Does the street in this segment have:

Street Characteristics	Yes	No	Unsure	N/A
a) Lanes less than, to equal-to, two lanes wide?	☐	☐	☐	☐
b) More than two lanes?	☐	☐	☐	☐
bi) Specify:				
c) Pavement access?	☐	☐	☐	☐
d) Have crossing assistance? (i.e., zebra, pelican, bridge...)	☐	☐	☐	☐
e) Have lighting for pavements?	☐	☐	☐	☐
f) Have pedestrianized access? (inc. restricted vehicular use)	☐	☐	☐	☐
g) Have transit stations featured? (i.e., bus stops)	☐	☐	☐	☐

PATHWAY CHARACTERISTICS

4) Does the pathway in this segment have:

Pathway Characteristics	Yes	No	Unsure	N/A
a) A width of less than, to equal-to, 'two-person' wide?	☐	☐	☐	☐
b) A greater width than 'two-person' wide?	☐	☐	☐	☐
c) Access for all users? (i.e., managed and maintained?)	☐	☐	☐	☐
d) Service amenities available? (i.e., benches, bins, signs...)	☐	☐	☐	☐
e) Specific functions/purposes? (i.e., cycle trails, national footpaths and/or bridle path)	☐	☐	☐	☐
ei) Specify:				

5) Is the pathway constructed/made up of:

Materials	Yes	No	Unsure	N/A
a) Natural Ground (i.e., fields, dirt paths)	☐	☐	☐	☐
ai) Specify:				
b) Gravel	☐	☐	☐	☐
c) Tarmac	☐	☐	☐	☐
d) Paving Slabs	☐	☐	☐	☐
e) Flag Stones	☐	☐	☐	☐
f) Cobbles	☐	☐	☐	☐
g) Concrete	☐	☐	☐	☐
h) Other:	☐	☐	☐	☐

6) How would you rate the topography of the terrain in this segment?

(1= Not at All; 2= Slightly; 3= Somewhat; 4= Very; 5= Extremely)

Rating Criteria	1	2	3	4	5	N/A
a) The steepness of the segment (i.e., hilly)	☐	☐	☐	☐	☐	☐
b) The levelness/flatness of the area	☐	☐	☐	☐	☐	☐

LAND USE ENVIRONMENT

7) Are residential and non-residential land uses visible in this segment?

Land Use Type	Yes	No	Unsure	N/A
a) Residential	☐	☐	☐	☐
b) Non-Residential	☐	☐	☐	☐

8) What types of land use are visible within this segment?

Residential	Yes	No	Unsure	N/A
a) Single family home (i.e., flat)	☐	☐	☐	☐
b) Two-, three-, four-, five-, or six family home	☐	☐	☐	☐
c) Communal Complex (i.e., student living)	☐	☐	☐	☐
d) Apartment building/tower block	☐	☐	☐	☐
e) Apartment over a retail building (multi-storey)	☐	☐	☐	☐
f) Mobile home or caravan	☐	☐	☐	☐
g) Mobile home or caravan park/community	☐	☐	☐	☐
h) Other:	☐	☐	☐	☐

Schools	Yes	No	Unsure	N/A
a) Nursery	☐	☐	☐	☐
b) Primary School	☐	☐	☐	☐
c) Secondary School	☐	☐	☐	☐
d) College or University Campus	☐	☐	☐	☐
e) Other:	☐	☐	☐	☐

Public Space	Yes	No	Unsure	N/A
a) Market Place	☐	☐	☐	☐
b) Square/Courtyard	☐	☐	☐	☐
c) Park	☐	☐	☐	☐
ci) with complete sports attire (posts, nets, etc.)	☐	☐	☐	☐
cii) with incomplete sports attire (missing elements)	☐	☐	☐	☐
d) Playground (i.e., with swings, slides, climbing frame...)	☐	☐	☐	☐
e) Landscaped Open Space (i.e., Public Gardens)	☐	☐	☐	☐

f) Playing Fields	☐	☐	☐	☐
g) Gardens	☐	☐	☐	☐
h) Beach	☐	☐	☐	☐

Recreational/Leisure/Fitness	Yes	No	Unsure	N/A
a) Indoor Fitness (i.e., Gym, Leisure Centre, Velodrome)	☐	☐	☐	☐
b) Outdoor Pool	☐	☐	☐	☐
c) Beach	☐	☐	☐	☐
d) Golf Course (including Mini Golf)	☐	☐	☐	☐
e) Sports/Field, Sports Courts (i.e., by a park/school)	☐	☐	☐	☐
f) Sports Track (i.e., outdoor by a park/school)	☐	☐	☐	☐
g) Marina/Harbour	☐	☐	☐	☐
h) Allotments	☐	☐	☐	☐
i) Other:	☐	☐	☐	☐

Public/Civic Building	Yes	No	Unsure	N/A
a) Post Office	☐	☐	☐	☐
b) Library	☐	☐	☐	☐
c) Community Centre	☐	☐	☐	☐
d) Police or Fire Department (including ambulance station)	☐	☐	☐	☐
e) Museum/Exhibition Centre	☐	☐	☐	☐
f) Other:	☐	☐	☐	☐

Institutional Buildings	Yes	No	Unsure	N/A
a) Place of Worship	☐	☐	☐	☐
b) Health or Social Services (i.e., hospital, adult care)	☐	☐	☐	☐
c) Other:	☐	☐	☐	☐

Commercial	Yes	No	Unsure	N/A
a) Petrol Station	☐	☐	☐	☐
b) Fast Food (i.e., stores selling carry-out food)	☐	☐	☐	☐
c) Other Restaurant Type	☐	☐	☐	☐
d) Off-Licence	☐	☐	☐	☐
e) Convenience or Grocery Store (i.e., small)	☐	☐	☐	☐
f) Supermarket (i.e., Tesco, Asda, etc.)	☐	☐	☐	☐
g) Bank or Credit Union	☐	☐	☐	☐

h) Pharmacy (i.e., Local companies, Lloyds)	☐	☐	☐	☐
i) Coffee Shop	☐	☐	☐	☐
j) Bars/Clubs	☐	☐	☐	☐
k) Movie Theatres/Cinemas	☐	☐	☐	☐
l) Other Entertainment (i.e., bowling)	☐	☐	☐	☐
m) Hotel, B&B, Hostel	☐	☐	☐	☐
n) Indoor Shopping Centres (i.e., Metro Centre)	☐	☐	☐	☐
o) Department Store (i.e., Debenhams, Fenwicks)	☐	☐	☐	☐
p) Strip Mall (i.e., multiple shops in linked buildings)	☐	☐	☐	☐
q) Charity Shops	☐	☐	☐	☐
r) Other Retail (i.e., bakery, rentals, florists)	☐	☐	☐	☐
s) Other Services (i.e., beautician, solicitors)	☐	☐	☐	☐
Offices/Services	Yes	No	Unsure	N/A
a) Office Buildings/Blocks	☐	☐	☐	☐
b) Office Space (i.e., vertical-mixed use)	☐	☐	☐	☐
c) Laundry/Dry Cleaners (including fabric repairs)	☐	☐	☐	☐
d) Utilities (i.e., water, electric, gas)	☐	☐	☐	☐
Industrial/Manufacturing	Yes	No	Unsure	N/A
a) Light- Motor Garages & Repairs (inc. car wash)	☐	☐	☐	☐
b) Medium to Heavy (i.e., chemical plants)	☐	☐	☐	☐
c) Warehouse/Storage Facilities	☐	☐	☐	☐
d) Agricultural Buildings (i.e., grain stores, barns, silos)	☐	☐	☐	☐
e) Other:	☐	☐	☐	☐
Transportation	Yes	No	Unsure	N/A
a) Harbour/Marina	☐	☐	☐	☐
b) Railway/Metro Station	☐	☐	☐	☐
c) Airport	☐	☐	☐	☐
d) Bus Station	☐	☐	☐	☐
e) Taxi Rank	☐	☐	☐	☐
Other	Yes	No	Unsure	N/A
a) Undeveloped Land	☐	☐	☐	☐
b) Agricultural Land				
bi) Field Crops	☐	☐	☐	☐
bii) Ploughed Fields	☐	☐	☐	☐
biii) Fallow Land	☐	☐	☐	☐
biv) Horticulture and Orchards	☐	☐	☐	☐
bv) Pasture (i.e., grazing)	☐	☐	☐	☐
bvi) Field Margin	☐	☐	☐	☐

c) Woodland Areas	☐	☐	☐	☐
d) Natural Features (i.e., hills, crags)	☐	☐	☐	☐
e) Other:	☐	☐	☐	☐

9) How many floors do most of the buildings appear to have in the area?

1	2	3	4	5	6+	N/A
☐	☐	☐	☐	☐	☐	☐

10) Is there evidence in the segment of vertical-mixed use buildings? (i.e., different land uses per floor)

Yes	☐	Unsure	☐
No	☐	N/A	☐

11) Is there any evidence of abandoned buildings or empty plots within the segment?

Yes	☐	Specify (%):	a) Previously developed, now vacant	☐
No	☐		b) Vacant Buildings	☐
Unsure	☐		c) Derelict land and buildings	☐
N/A	☐			

12) What types of 'nature' features are visible in this segment?

Type of Feature	Yes	No	Unsure	N/A
a) Large Body of Water (i.e., ocean, lake, reservoir)	☐	☐	☐	☐
b) Small Body of Water (i.e., pond, stream, brook)	☐	☐	☐	☐
c) Water Systems (i.e., river, waterfall, canal)	☐	☐	☐	☐
d) Hills and/or Mountains	☐	☐	☐	☐
e) Valleys and/or Floodplains	☐	☐	☐	☐
f) Wider Open Space (i.e., fields, moors, meadows)	☐	☐	☐	☐
g) Wooded Space (i.e., forests, woods)	☐	☐	☐	☐
h) Man-made features (i.e., golf course, off-road track)	☐	☐	☐	☐

13) Does the segment have a significant ‘open view’ of an object/space/environment, not directly in the audit area?

Type of Feature	Yes	No	Unsure	N/A
a) Naturally Existing Landscapes (i.e., hills and valleys)	☐	☐	☐	☐
b) Man-Made ‘Nature’ Landscapes (i.e., golf course)	☐	☐	☐	☐
c) Managed, Open Landscapes (i.e., fields and meadows)	☐	☐	☐	☐
d) Woodland (i.e., forestry and wooded areas)	☐	☐	☐	☐
e) Water Systems (i.e., rivers, drainage basins, water bodies)	☐	☐	☐	☐
f) Populated Landscapes (i.e., towns and cities)	☐	☐	☐	☐
g) Historic/Symbolic Landscapes (i.e., landmarks, churches)	☐	☐	☐	☐

FACILITIES

14) What other types of facility are visible in this segment?

Facility Type	Yes	No	Unsure	N/A
a) Parking Lot/Garage	☐	☐	☐	☐
b) Parking Spaces (i.e., street)	☐	☐	☐	☐
c) Driveways (i.e., residential inc. non-residential)	☐	☐	☐	☐
d) Abandoned Building or Plot	☐	☐	☐	☐
e) Railroad, Bridge, Tunnel, Slip Road, or Overpass	☐	☐	☐	☐
f) Other:	☐	☐	☐	☐

15) What types of service amenities are present within the segment?

Service Amenity	Yes	No	Unsure	N/A
a) Equipment Rental	☐	☐	☐	☐
b) Sports Stands/Seating	☐	☐	☐	☐
c) Picnic Facilities (i.e., tables)	☐	☐	☐	☐
d) Water Foundations (i.e., drinking)	☐	☐	☐	☐
e) Public Toilets	☐	☐	☐	☐
f) Public Telephones	☐	☐	☐	☐
g) Bins	☐	☐	☐	☐
h) Tourist Information Desks	☐	☐	☐	☐
i) Visitor Centres	☐	☐	☐	☐
j) Other:	☐	☐	☐	☐

AESTHETICS (Sensory Attributes)

16) Regarding the maintenance of the area, is there evidence of physical disorder?
(i.e., litter, broken glass/windows, graffiti, discarded items, other forms of vandalism)

Yes	☐	Unsure	☐
No	☐	N/A	☐

17) Regarding the visual outlook of the area, are there any attractive features within this segment?

Criteria	Yes	No	Unsure	N/A
a) Architecture & Design	☐	☐	☐	☐
b) Building Variety	☐	☐	☐	☐
c) Human Traffic	☐	☐	☐	☐
d) Vegetation (i.e., wooded areas, flowers, hedgerows)	☐	☐	☐	☐
e) Natural Features (i.e., hills/mountains/rivers)	☐	☐	☐	☐

18) Is there evidence of either forms of pollution, within this segment?

Pollutant Category	Yes	No	Unsure	N/A
a) Air Pollution	☐	☐	☐	☐
ai) Specify:				
b) Noise Pollution	☐	☐	☐	☐
bi) Specify:				

19) Please rate a response to the following questions:

(1= Not at All; 2= Slightly; 3= Somewhat; 4= Very; 5= Extremely)

Rating Criteria	1	2	3	4	5	N/A
a) How safe do you feel walking through this area?	☐	☐	☐	☐	☐	☐
b) How historically significant do you think the area is?	☐	☐	☐	☐	☐	☐
c) How picturesque do you think the town/city is?	☐	☐	☐	☐	☐	☐
d) How 'smelly/aromatic/pungent' do you think the area is?	☐	☐	☐	☐	☐	☐

SOCIAL ENVIRONMENT

20) Are there people visible in this segment?

Yes	☐
No	☐

21) Are there any animals visible in this segment?

Yes ☐ Specify:
 No ☐

22) What kinds of social activities are visible, at present, in the segment?

Activity Criteria	Visible	Not Visible
a) Are there any children visible in this segment? (i.e., less than 12 years old)	☐	☐
b) Are there any children engaging in physical activities? (i.e., hiking, playing sport, running, or climbing)	☐	☐
c) Are there any children engaging in day-to-day activities? (i.e., shopping, dog walking)	☐	☐
d) Are there any children engaging in visitors/tourist-based activities? (i.e., landmarks, WHO sites)	☐	☐
e) Are there any teenagers or adults visible in this segment? (i.e., 13 to 65 years old)	☐	☐
f) Are there any teenagers or adults engaging in physical activities? (i.e., hiking, playing sport, running, or climbing)	☐	☐
g) Are there any teenagers or adults engaging in day-to-day activities? (i.e., shopping, dog walking)	☐	☐
h) Are there any teenagers or adults engaging in visitors/tourist-based activities? (i.e., landmarks, WHO sites)	☐	☐
i) Are there any older adults visible in this segment? (i.e., +65 years old)	☐	☐
j) Are there any older adults engaging in physical activities? (i.e., hiking, playing sport, running, or climbing)	☐	☐
k) Are there any older adults engaging in day-to-day activities? (i.e., shopping, dog walking)	☐	☐
l) Are there any older adults engaging in visitors/tourist-based activities? (i.e., landmarks, WHO sites)	☐	☐
m) Are there any people stopping to talk or greet one another?	☐	☐
n) Are there any people fighting, acting hostile, or threatening?	☐	☐

ADDITIONAL NOTES/OBSERVATIONS

Comments:

Appendix B- Questionnaire

This aim of this survey is to collect data for a Newcastle University PhD research project, which investigates how people (locals, tourists, and visitors) respond to the landscape around them. This information will be used to develop new visual and statistical representations of people's perceptions of the landscape (such as new kinds of maps).

The questionnaire will collect individuals' opinions of landscape at three specific locations, Stanhope, Esh Winning and Durham City. At each location, the questionnaire will ask you, the participant, about your thoughts and feelings of the area and will only take a few moments of your time.

For participant protection, all individuals will be held anonymous whilst gathered information will be kept strictly confidential, secure, and handled sensitively. For those people who may be cited within the research, each person will be referred to as 'Individual' and allocated a letter (i.e., Individual A), with no use of descriptive language to prevent the participant being identified.

Participants will NOT be contacted for further information, or to take further surveys or interviews, unless the participant specifically requests to be kept informed of the research. All participants will be offered the chance to 'opt out' at any point of the data collection and throughout the research, with all corresponding details being removed from the research.

Thank you for agreeing to take part in this research.

1) What is the reason for your visit today?

Please select ONE option:

Day Out with Family/Friends etc.	☐
Planned Holiday Excursion (e.g., Agency/Coach Trip)	☐
Personal Holiday	☐
Work	☐
University (e.g., A student at the local university)	☐
General Daily Activities (e.g., I am a local resident)	☐
Leisure Activity (e.g., Walking, Rambling)	☐
N/A (prefer not to say)	☐
Other (please state): _____	☐

1a) Where did you hear about this location?

Please select ALL those that apply, from the list below:

TV	☐	Email	☐
Radio	☐	Online Subscription/Membership	☐
Place of Residence	☐	Newspapers/Magazines/Leaflets	☐
Tourist Info Office	☐	Internet (e.g., Website, Trip Advisor)	☐
Word of Mouth	☐	Social Media (e.g., Facebook, Twitter)	☐
		Other (please state): _____	☐

2) Have you ever visited this location before?

Please select one from the options below:

I live/work/study here	☐
Yes	☐
No	☐
N/A (prefer not to say)	☐

2a) If you answered 'Yes', how many times have you visited?

Please select one from the options below:

1-3	☐
4-6	☐
7-9	☐
10+	☐
N/A (prefer not to say)	☐

- 3) Thinking about where you are standing in now, what are your initial thoughts/feelings of the area?
Please provide *THREE* key terms below:

- 4) To what extent do you agree with the following statements?
Please indicate just *ONE* column of agreement per statement:

Attachment to Place

a) I feel a personal connection to (PLACE NAME) and its settings and services.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
b) This landscape reminds me of past times and brings back memories.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
c) This village/town/city is important to me because my family is originally from here.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
d) After visiting (PLACE NAME), I feel that the area means a lot to me.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
e) I know (PLACE NAME) really well.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
f) I would like to spend more time here if I could.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5

Social Relations

g) I care about the future of (PLACE NAME) and the surrounding landscape.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
h) I feel like I am a part of the community here.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
i) This village/town/city is not just my place of residence; my social life is here too.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
j) I have enjoyed my experience here in (PLACENAME)					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5

Adaptability of Use

k) I feel that (PLACE NAME) is very accessible and I am able to move freely within the area.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
l) During my visit (PLACE NAME), I have enjoyed learning about the local and natural history of the area.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
m) During my visit (PLACE NAME), I have enjoyed learning more about the countryside.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
n) I think that there are plenty of things to do here.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
o) I feel safe and secure whilst being here.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5

Landscape Appreciation

p) The landscape here in (PLACE NAME) has many local, historical, and cultural features.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
q) During my visit to (PLACE NAME), I am able to feel closer to nature.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
r) During my visit, I enjoy looking at the views of the surrounding landscape.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
s) I enjoy visiting (PLACE NAME) more so than any other place.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
t) I would like to visit (PLACE NAME) again in the future.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5

Landscape Satisfaction

u) I like this part of the landscape and its topography (i.e., the hills, rivers, and valleys).					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
v) I feel that there is more to be done to improve the environment here in (PLACE NAME).					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5
w) I think it is important to maintain and look after these kinds of environments.					
N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	1	2	3	4	5

- 5) On a scale of 1 (not at all important) to 5 (very important), how important do you think it is to educate and raise awareness of these kinds of places?

N/A		Not at All Important		Neither		Very Important	
0	1	2	3	4	5		

- 6) On a scale of 1 (not at all important) to 5 (very important), how important do you think it is to preserve and look after these areas, particularly for future generations?

N/A		Not Very Important		Neither		Very Important	
0	1	2	3	4	5		

- 7) How would you share your experiences of visiting this location with others?

Please select ALL those that apply to you, from the list below:

Art (e.g., painting and sketching)	☐	Photography	☐
Crafts (e.g., pottery and textiles)	☐	Film/Movie	☐
Verbal Discussions (e.g., with friends/family)	☐	Tourist Information Sites (e.g., Trip Advisor)	☐
Social Media (e.g., Facebook, Blogs, Twitter)	☐	Writing & Literature (e.g., Diaries, Poetry, Story Writing)	☐
		Other (please state): _____	☐

Finally, just a few short questions about yourself:

- 8) Please indicate your gender from the list below:

Female	☐
Male	☐
N/A (prefer not to say)	☐

- 9) Which age bracket do you, the participant, come under?

Please select ONE applicable field:

18-25	☐	56-65	☐
26-35	☐	66-75	☐
36-45	☐	76+	☐
46-55	☐	N/A (prefer not to say)	☐

10) Please indicate your area of employment by occupation from one of the twelve categories below:

Please select ONE applicable field:

Managers, Directors & Senior Officials (e.g., Chief Executives, Production Managers/Directors)	☐
Professional Occupations (e.g., Natural & Social Sciences, Engineering, Health, Legal Professions, Teaching)	☐
Associate Professional & Technical Occupations (e.g., Technicians, IT, Protective Service Occupations, Sports & Fitness)	☐
Administrative & Secretarial Occupations (e.g., Government & Related, Finance, Sales, Office Managers/Supervisors)	☐
Skilled Trades Occupations (e.g., Agricultural, Metal & Welding, Vehicle Trades, Electronics, Construction/Building)	☐
Caring, Leisure & Other Service Occupations (e.g., Childcare, Animal Care & Control, Leisure & Travel Services)	☐
Sales & Customer Service Occupations (e.g., Sales Assistants, Cashiers, Supervisors, Customer Service)	☐
Process, Plant & Machine Operatives (e.g., Food/Drink/Tobacco, Energy/Water/Sewage, Assembly/Construction, Transportation)	☐
Elementary Occupations (e.g., Agricultural, Construction, Process Plant, Administrative, Security, Cleaning, Sales)	☐
Armed Forces Operations (including those in training) (e.g., Auxiliary Services, Army, Navy, Air Force, and other Military Services)	☐
Currently Registered in Full-Time, Higher Education (e.g., A student studying a full-time course at a university, academy, or other institute)	☐
Retired	☐
N/A (prefer not to say)	☐

10a) If possible, please state more specifically your profession/job title below,
OR please state which university/academy/institute you are currently attending:

11) Please provide the first half of your postcode: (e.g., NE4, BL12)

This is to help the researcher understand how far people have travelled to visit these locations.

You have successfully completed the questionnaire.
Thank you very much for your time and participation.

Appendix C- Participant Information Sheet: Focus Group Project on Map Usability*

*Official copies of this document are on university headed paper.

Researcher: Isabel H. Williams

Contact Details:

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Office: W318

Durham University, South Road,

(Geography, IHRR Building)

Durham, DH1 3LE

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You are invited to take part in a study that I am conducting to investigate map usability, related to the ESRC-funded research in my PhD from Newcastle University. Before you decide whether to agree to take part, please read the following information on the purpose of the research and what is involved as a participant. Please read the following information carefully. Please get in contact if there is anything that is not clear or if you would like more information.

The aim of this study is to investigate map usability and consider how cartographic representations (i.e., maps) can be used to present people's emotions, feelings, and responses. It involves inviting participants to observe and assess a range of maps that present this information in a variety of different ways and consider the effectiveness of each. Participants will complete a short survey about the various map designs, purpose, and ability to effectively communicate information using various symbols and representation formats. Responses will be recorded using a series of tick-boxes and short-answer questions, and only need to be a sentence or two in length. This should take no longer than an hour to an hour and thirty minutes. Participants will then be asked to attend an online focus group, to discuss their thoughts and ideas. The study is to be completed within the next month.

You have been invited to take part because you have completed the Level 2 Social Research Methods block, Practical A: Spatial Data Analysis. With your research training and experience, we know that poorly designed maps can fail to convey their messages, trends, and patterns. I would like your help to assess my newly designed maps and consider their usability and how these may be improved to effectively communicate their message.

Your participation is voluntary, and you do not have to agree to take part. If you do agree to take part, you can withdraw at any time without giving a reason and all associated information

will be destroyed. Additionally, your participation has no bearing on future marks nor will there be any form of impact that your participation might result in. It does not and will not have any impact or implication regarding your university studies.

If you agree to participate in the study, I will send a 'Map Usability Pack' containing further information and instructions, a survey and a series of maps relating to the project. I will then arrange a focus group session through Microsoft Teams to host an informal conversation with other participants lasting roughly 45 minutes to an hour. In this focus group, I would like to discuss your thoughts and ideas about the various maps, such as your understanding of the representations, their strengths, weaknesses, and any potential changes that could be made to improve the maps. In both the provided survey and focus group session, you can omit any questions that you do not wish to answer.

I will record the focus group session through Microsoft Teams. I will then analyse the recording to supplement the data collected in the completed surveys. I will report the insights gained from the session as part of the project write-up, where all responses given will be anonymised and kept confidential; focus group interviews will be anonymised at the point of transcription. Recordings and transcripts will be kept secure and private on an external hard-drive, accessible by only myself, the researcher. All files containing any information you give will be password protected.

In the project write-up, no information will be included that will make it possible to identify you individually. If the data is published in the future, it will be entirely anonymous and will not be identifiable as yours. There will be no way of linking responses back to you as the individual. This information will not identify you and will not be combined with other information in a way that could identify you.

I will not collect or ask you to provide any personal data. An email address is required for recruitment and contact and will only be used for the purpose research. It will not be used to contact you in the future.

All research data and records needed to validate the research findings will be stored for ten years after the end of the project.

You are free to decide whether, or not, to participate. If you decide to participate, you are free not to answer specific questions and you are free to withdraw at any time, without any negative consequences for you.

Please contact me if you have any questions, using the provided contact details below.

Thank you for reading this information and considering taking part in this study.

A handwritten signature in black ink, appearing to read 'Isabel Williams', with a horizontal line underneath.

Signed: Isabel Williams

Date:

Appendix D- Focus Group Participant Consent Form*

*Official copies of these documents are on university headed paper.

Project Title: Investigating Map Usability

Researcher: Isabel H. Williams

Department: Department of Geography

Contact Details:

Department of Geography Durham University South Road Durham DH1 3LE	School of Geography, Politics and Sociology Newcastle University Newcastle upon Tyne, UK NE1 7RU
Email: isabel.h.williams@durham.ac.uk	Email: i.h.williams1@newcastle.ac.uk

This form is to confirm that you understand what the purpose of the project is, what is involved and that you are happy to take part. Please initial each box to indicate your agreement:

I confirm that I have read and understand the information sheet and the privacy notice for the above project.	
I have had sufficient time to consider the information and ask any questions I might have, and I am satisfied with the answers I have been given.	
I consent to being audio/video recorded and understand how the recordings will be used in the research outputs.	
I understand who will have access to the data provided, how the data will be stored and what will happen to the data at the end of the project.	
I understand that anonymised (i.e., not identifiable) versions of my data may be archived and shared with others for legitimate research purposes.	
I agree to take part in the above project.	
I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason.	

Participant's Signature: _____ **Date:** _____

Name (IN BLOCK LETTERS): _____

Appendix E- Focus Group Project on Map Usability: Usability Tasks Handbook

Welcome!

Thank you for agreeing to take part in the study. The aim is to investigate map usability and consider how cartographic representations (i.e., maps) can be used to present people's emotions, feelings, and responses. It involves asking participants to observe and assess a range of maps that present this information in a variety of different ways and consider the effectiveness of each. We know that poorly designed maps can fail to convey their messages, trends, and patterns. I would like your help to assess my newly designed maps and consider their usability and how these may be improved to effectively communicate their message.

Prior to the focus group session, you will complete this short survey about the various designs, purpose, and ability to effectively communicate information using various symbols and representation formats. Your responses will be recorded using a series of tick-boxes and short-answer questions. These only need to be a sentence or two in length. This should take no longer than an hour to an hour and thirty minutes.

Once complete, please send your completed Usability Tasks Handbook to Isabel at the email address noted in the handbook conclusion, prior to your attendance to the online focus group. Upon attending, you will have the opportunity to discuss your thoughts and ideas about the various maps.

Finally, a quick reminder that your participation is voluntary, and you do not have to agree to take part. If you do agree to take part, you can withdraw at any time without giving a reason and all associated information will be destroyed.

I will record the focus group session through Microsoft Teams. I will then analyse the recording to supplement the data collected in the completed surveys. I will report the insights gained from the session as part of the project write-up, where all responses given will be anonymised and kept confidential; focus group interviews will be anonymised at the point of transcription. Recordings and transcripts will be kept secure and private on an external hard-drive, accessible by only myself, the researcher. All files containing any information you give will be password protected.

Finally, a reminder that your participation has no bearing on future marks nor will there be any form of impact that your participation might result in. It does not and will not have any impact or implication regarding your university studies.

Further details can be found in the provided Participant Information Sheet.

Map Usability

There are three different Likert innovations for testing, and these have been sorted and grouped by type for the usability test.

- Likert Pie Chart Map of Attachment to Place
- Likert Grid Map of Attachment to Place
- Likert Radar Map of Attachment to Place

Each type of innovation presents the Likert scale responses for six survey questions relating to Attachment to Place (Place Attachment). The data is plotted in accordance with an associated data collection point (DCP), being where the information was collected during fieldwork. For your convenience, I have provided a map of the data collection points on page three.

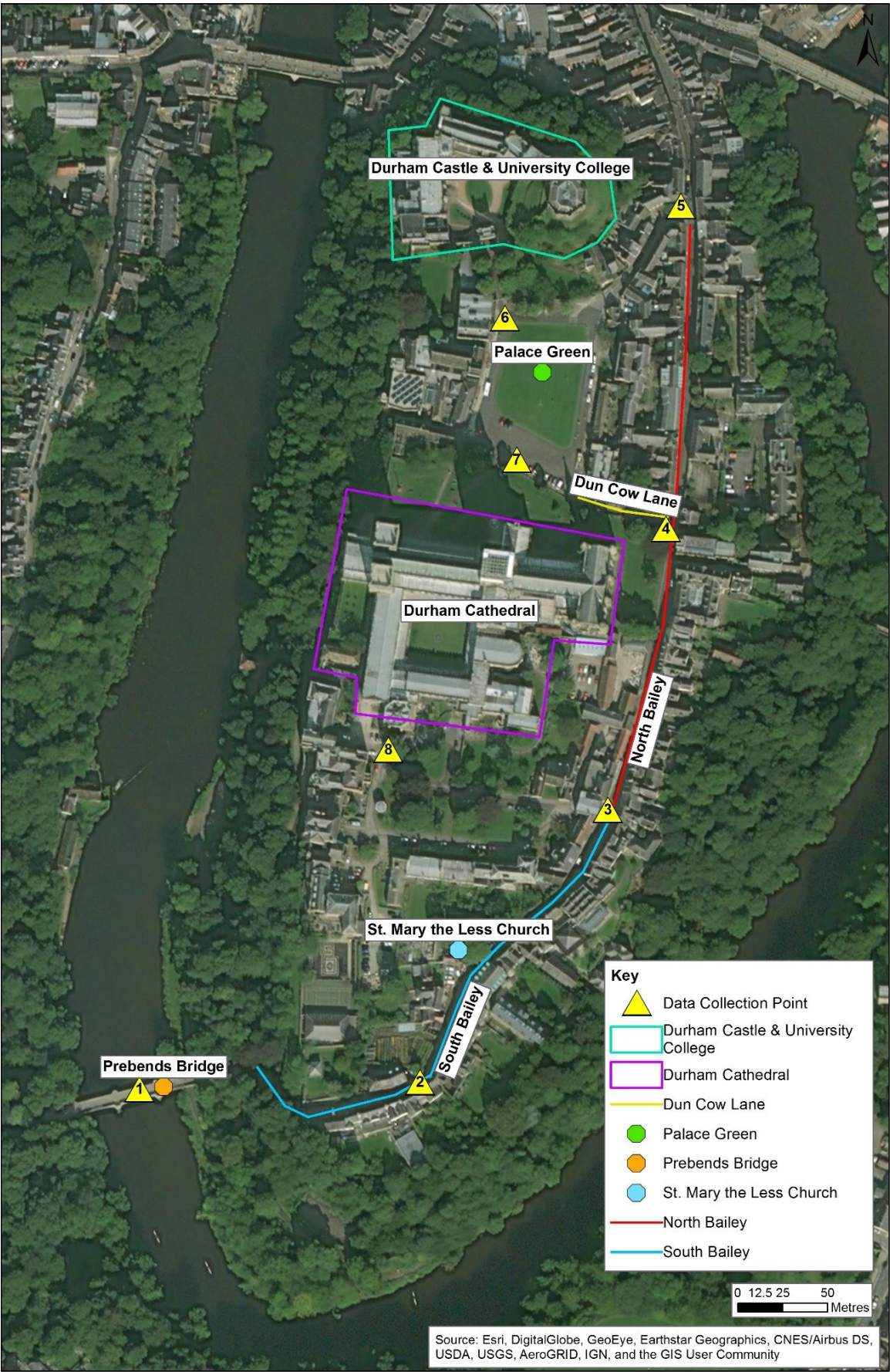
The six Likert survey questions are as follows:

- a) I feel a personal connection to Durham and its settings and services.
- b) This landscape reminds me of past times and brings back memories.
- c) This village/town/city is important to me because my family is originally from here.
- d) After visiting Durham, I feel that the area means a lot to me.
- e) I know Durham really well.
- f) I would like to spend more time here if I could.

The following table provides further information regarding each Likert innovation group, including the corresponding folder/file names for you to access the maps:

Map Group	Quantity	Information
Likert Pie Chart Map of Attachment to Place	2 (Total 12)	Each of the six survey questions are mapped independently. For the usability testing, the test will focus on <u>Question A</u> due to time, though all 12 maps have been provided for context. These are sorted into the following folders: ▪ ESRI Streets Basemap ▪ ESRI Streets Basemap Nested Legend
Likert Grid Map of Attachment to Place	2	File Names: ▪ ESRI Streets Basemap with questions outlined ▪ ESRI Streets Basemap without questions outlined
Likert Radar Map of Attachment to Place	2	File Names: ▪ ESRI Streets Basemap with charts detailing question number ▪ ESRI Streets Basemap with charts detailing question description

Data Collection Points (DCPs)



Likert Pie Chart Map of Attachment to Place (1)

Each of the six survey questions are mapped independently. For the usability testing, the test will focus on Question A “a) I feel a personal connection to Durham and its settings and services”, though all maps have been provided for context.

Please start with the Likert Pie Chart Map titled “Likert Pie Chart Q4A”, in the folder “ESRI Streets Basemap” and complete the following tasks.

1. Starter Activity: Determining the Use of a Map

The purpose of this activity is to initiate your engagement with the map innovation and ensure that you can read the provided maps accordingly.

Please answer the following questions:

- a) What does the symbol at the data collection point outside of Durham Cathedral (DCP7) tell us about the response from the sample?
- b) Are there are geographical trends or patterns in the data, such as clusters of high or low Likert ratings?
- c) Are the Likert response patterns similar or do they differ across the research location?

Using the scale below, please indicate your first impression of the Likert innovation map:

N/A	Very Poor	Poor	Average	Good	Excellent
☐	☐	☐	☐	☐	☐

2. Task-Based Testing

The following three tasks have been identified and designed to test how you as map users explore the data, looking for similarities and differences, interpreting findings and observing the patterns and trends within each Likert map.

Please answer the following questions:

- a) Locate the data collected at DCP1 on Prebends Bridge. What is the mode Likert response presented?

- b) From the data collected, in which areas did participants disagree and not feel a personal connection to Durham?
- c) Observing the pattern for those who responded 'disagree' to feeling a personal connection to Durham, briefly summarise the presented results.

3. Design and Aesthetic Testing

This activity is split into three parts: map style, legend design and symbology and representation. As each map has slightly different design principles and characteristics, you are now going to rank your thoughts about each. You can then provide further detail and justification for your answers in the focus group. Using the Likert scales below, please indicate the most appropriate response that corresponds to the provided statement:

	N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Likert Scale:	0	1	2	3	4	5
<i>Map Design</i>						
The basemap is clear and effective.	☐	☐	☐	☐	☐	☐
The arrangement of the map contents (i.e., legend, title, scale bar, etc.) are suitably placed.	☐	☐	☐	☐	☐	☐
The labelling of the sample size is helpful and informative.	☐	☐	☐	☐	☐	☐
The map is visually appealing.	☐	☐	☐	☐	☐	☐
The map is easy to use and interpret.	☐	☐	☐	☐	☐	☐

The pie charts are an effective type of representation.	☐	☐	☐	☐	☐	☐

Legend Design

The legend is clear and suitably formatted.	☐	☐	☐	☐	☐	☐
The double labelling of the sample size is useful (i.e., on the map and in the legend).	☐	☐	☐	☐	☐	☐
The legend is easy to use and understand.	☐	☐	☐	☐	☐	☐

Symbology and Representation

The colour choices are effective and communicate the findings well.	☐	☐	☐	☐	☐	☐
The data representations (i.e., pie charts) are clear and easy to read.	☐	☐	☐	☐	☐	☐
The information is accessible and easy to interpret.	☐	☐	☐	☐	☐	☐
I understand what the map is showing.	☐	☐	☐	☐	☐	☐

4. Attitude Testing

Using the five-point scales below, indicate the point that best represents your attitude towards the map.

Helpful					Hindering
☐	☐	☐	☐	☐	
Entertaining					Boring
☐	☐	☐	☐	☐	
Interested to use					Not interested to use
☐	☐	☐	☐	☐	
Well-organised					Poorly organised
☐	☐	☐	☐	☐	
Elegant					Drab
☐	☐	☐	☐	☐	
Innovative					Conventional
☐	☐	☐	☐	☐	
Shows Likert responses clearly					Shows Likert responses poorly
☐	☐	☐	☐	☐	
Easy to understand					Difficult to understand
☐	☐	☐	☐	☐	

Now that you have finished your evaluation of the “ESRI Streets Basemap”, please move on to the next map in the folder “ESRI Streets Basemap Nested Legend”, titled “Likert Pie Chart Nested Q4A” and repeat the previous tasks again below.

Likert Pie Chart Map of Attachment to Place (2)

Alike the previous map, each of the six survey questions are mapped independently. For the usability testing, this test will focus on Question A, “a) I feel a personal connection to Durham and its settings and services”, though all maps have been provided for context.

In the second folder ‘ESRI Streets Basemap Nested Legend’, turn your attention to the “Likert Pie Chart Nested Q4A” map and complete the following tasks below.

1. Starter Activity: Determining the Use of a Map

The purpose of this activity is to initiate your engagement with the map innovation and ensure that you can read the provided maps accordingly.

Please answer the following questions:

- a) What does the symbol at DCP5, the most northern point on the map, tell us about the response from the sample?

Using the scale below, please indicate your first impression of the Likert innovation map:

N/A	Very Poor	Poor	Average	Good	Excellent
☐	☐	☐	☐	☐	☐

2. Task-Based Testing

The following three tasks have been identified and designed to test how you as map users explore the data, looking for similarities and differences, interpreting findings and observing the patterns and trends within each Likert map.

Please answer the following questions:

- a) Locate the data collected at DCP3, at the top of South Bailey. What is the mode Likert response presented?
- b) From the data collected, in which areas did participants agree that they felt a personal connection to Durham?

- c) Observing the pattern for those who responded ‘agree’ to feeling a personal connection to Durham, briefly summarise the presented results.

3. Design and Aesthetic Testing

This activity is split into three parts: map style, legend design and symbology and representation. As each map has slightly different design principles and characteristics, you are now going to rank your thoughts about each. You can then provide further detail and justification for your answers in the focus group. Using the Likert scales below, please indicate the most appropriate response that corresponds to the provided statement:

	N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Likert Scale:	0	1	2	3	4	5
<i>Map Design</i>						
The basemap is clear and effective.	☐	☐	☐	☐	☐	☐
The arrangement of the map contents (i.e., legend, title, scale bar, etc.) are suitably placed.	☐	☐	☐	☐	☐	☐
The labelling of the sample size is helpful and informative.	☐	☐	☐	☐	☐	☐
The map is visually appealing.	☐	☐	☐	☐	☐	☐
The map is easy to use and interpret.	☐	☐	☐	☐	☐	☐
The pie charts are an effective type of representation.	☐	☐	☐	☐	☐	☐
<i>Legend Design</i>						

The legend is clear and suitably formatted.	☐	☐	☐	☐	☐	☐
The double labelling of the sample size is useful (i.e., on the map and in the legend).	☐	☐	☐	☐	☐	☐
The provision of the 'Sample Size' using proportional symbols is helpful.	☐	☐	☐	☐	☐	☐
The legend is easy to use and understand.	☐	☐	☐	☐	☐	☐

Symbology and Representation

The colour choices are effective and communicate the findings well.	☐	☐	☐	☐	☐	☐
The data representations (i.e., pie charts) are clear and easy to read.	☐	☐	☐	☐	☐	☐
The information is accessible and easy to interpret.	☐	☐	☐	☐	☐	☐
I understand what the map is showing.	☐	☐	☐	☐	☐	☐

4. Attitude Testing

Using the five-point scales below, indicate the point that best represents your attitude towards the map.

Helpful					Hindering
☐	☐	☐	☐	☐	
Entertaining					Boring
☐	☐	☐	☐	☐	
Interested to use					Not interested to use
☐	☐	☐	☐	☐	
Well-organised					Poorly organised
☐	☐	☐	☐	☐	
Elegant					Drab
☐	☐	☐	☐	☐	
Innovative					Conventional
☐	☐	☐	☐	☐	
Shows Likert responses clearly					Shows Likert responses poorly
☐	☐	☐	☐	☐	
Easy to understand					Difficult to understand
☐	☐	☐	☐	☐	

Now that you have finished your evaluation, please move on to the next genre of Likert innovation, being the Likert Grid Map of Attachment to Place.

Likert Grid Map of Attachment to Place (1)

The next type of Likert innovation plots all six survey questions into one cartographic representation and uses the average response to present the results for each. For reference, the six Likert survey questions are listed in the Welcome! section of this handbook and responses follow the Likert Scale of 1 (Strongly Disagree) to 5 (Strongly Agree) accordingly.

Please start with the Likert Grid Map titled “ESRI Streets Basemap with questions outlined” and complete the following tasks.

1. Starter Activity: Determining the Use of a Map

The purpose of this activity is to initiate your engagement with the map innovation and ensure that you can read the provided maps accordingly.

Please answer the following questions:

- a) What do the symbols at the data collection point outside of Durham Cathedral (DCP7) tell us about the response from the sample?
- b) Are there are geographical trends or patterns in the data, such as clusters of high or low Likert ratings?
- c) Are the Likert response patterns similar or do they differ across the research location?

Using the scale below, please indicate your initial impression of the Likert innovation map:

N/A	Very Poor	Poor	Average	Good	Excellent
☐	☐	☐	☐	☐	☐

2. Task-Based Testing

The following three tasks have been identified and designed to test how you as map users explore the data, looking for similarities and differences, interpreting findings and observing the patterns and trends within each Likert map.

Please answer the following questions:

- a) Locate the data collected at DCP3 at the top of South Bailey. Which question(s) produced a result suggesting participants were developing an attachment to Durham?
- b) From the data collected, which DCP presents the strongest evidence of Attachment to Place?
- c) Look at the results presented for question c) “This village/town/city is important to me because my family is originally from here” across Durham. Briefly summarise the presented results.

3. Design and Aesthetic Testing

This activity is split into three parts: map style, legend design and symbology and representation. As each map has slightly different design principles and characteristics, you are now going to rank your thoughts about each. You can then provide further detail and justification for your answers in the focus group. Using the Likert scales below, please indicate the most appropriate response that corresponds to the provided statement:

	N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Likert Scale:	0	1	2	3	4	5
<i>Map Design</i>						
The basemap is clear and effective.	☐	☐	☐	☐	☐	☐
The arrangement of the map contents (i.e., legend, title, scale bar, etc.) are suitably placed.	☐	☐	☐	☐	☐	☐
The provided details for each survey question are helpful.	☐	☐	☐	☐	☐	☐
The map is visually appealing.	☐	☐	☐	☐	☐	☐

The map is easy to use and interpret.	☐	☐	☐	☐	☐	☐
The Likert grids are an effective type of representation.	☐	☐	☐	☐	☐	☐

Legend Design

The legend is clear and suitably formatted.	☐	☐	☐	☐	☐	☐
The legend is easy to use and understand.	☐	☐	☐	☐	☐	☐
The provided Survey Symbolology is useful and effective.	☐	☐	☐	☐	☐	☐
The use of two legends is clear and easy to understand.	☐	☐	☐	☐	☐	☐

Symbolology and Representation

The colour choices are effective and communicate the findings well.	☐	☐	☐	☐	☐	☐
The data representations (i.e., Likert grids) are clear and easy to read.	☐	☐	☐	☐	☐	☐
The information is accessible and easy to interpret.	☐	☐	☐	☐	☐	☐
I understand what the map is showing.	☐	☐	☐	☐	☐	☐

4. Attitude Testing

Using the five-point scales below, indicate the point that best represents your attitude towards the map.

Helpful					Hindering
☐	☐	☐	☐	☐	
Entertaining					Boring
☐	☐	☐	☐	☐	
Interested to use					Not interested to use
☐	☐	☐	☐	☐	
Well-organised					Poorly organised
☐	☐	☐	☐	☐	
Elegant					Drab
☐	☐	☐	☐	☐	
Innovative					Conventional
☐	☐	☐	☐	☐	
Shows Likert responses clearly					Shows Likert responses poorly
☐	☐	☐	☐	☐	
Easy to understand					Difficult to understand
☐	☐	☐	☐	☐	

Now that you have finished your evaluation of the “ESRI Streets Basemap with questions outlined”, please move on to the next map “ESRI Streets Basemap without questions outlined” and repeat the following tasks.

Likert Grid Map of Attachment to Place (2)

Alike the previous, this type of Likert innovation plots all six survey questions into one cartographic representation and uses the average response to present the results for each. For reference, the six Likert survey questions are listed in the Welcome! section of this handbook and responses follow the Likert Scale of 1 (Strongly Disagree) to 5 (Strongly Agree) accordingly.

Turning your attention to the “ESRI Streets Basemap without questions outlined”, complete the following tasks below.

1. Starter Activity: Determining the Use of a Map

The purpose of this activity is to initiate your engagement with the map innovation and ensure that you can read the provided maps accordingly.

Please answer the following questions:

- a) What do the symbols at DCP4, outside St. Chad’s College, tell us about the response from the sample?

Using the scale below, please indicate your initial impression of the Likert innovation map:

N/A	Very Poor	Poor	Average	Good	Excellent
☐	☐	☐	☐	☐	☐

2. Task-Based Testing

The following three tasks have been identified and designed to test how you as map users explore the data, looking for similarities and differences, interpreting findings and observing the patterns and trends within each Likert map.

Please answer the following questions:

- a) Locate the data collected at DCP2 on South Bailey. Which question(s) results suggest participants were developing an attachment to Durham?
- b) From the data collected, which DCP shows the weakest evidence of Attachment to Place?

- c) Look at the results presented for the theme ‘Personal Connections’ across Durham.
Briefly summarise the presented results.

3. Design and Aesthetic Testing

This activity is split into three parts: map style, legend design and symbology and representation. As each map has slightly different design principles and characteristics, you are now going to rank your thoughts about each. You can then provide further detail and justification for your answers in the focus group. Using the Likert scales below, please indicate the most appropriate response that corresponds to the provided statement:

	N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Likert Scale:	0	1	2	3	4	5
<i>Map Design</i>						
The basemap is clear and effective.	☐	☐	☐	☐	☐	☐
The arrangement of the map contents (i.e., legend, title, scale bar, etc.) are suitably placed.	☐	☐	☐	☐	☐	☐
The map is visually appealing.	☐	☐	☐	☐	☐	☐
The map is easy to use and interpret.	☐	☐	☐	☐	☐	☐
The Likert grids are an effective type of representation.	☐	☐	☐	☐	☐	☐
<i>Legend Design</i>						
The legend is clear and suitably formatted.	☐	☐	☐	☐	☐	☐

The legend is easy to use and understand.	☐	☐	☐	☐	☐	☐
The provided Survey Symbology is useful and effective.	☐	☐	☐	☐	☐	☐
The use of two legends is clear and easy to understand.	☐	☐	☐	☐	☐	☐

Symbology and Representation

The colour choices are effective and communicate the findings well.	☐	☐	☐	☐	☐	☐
The data representations (i.e., Likert grids) are clear and easy to read.	☐	☐	☐	☐	☐	☐
The information is accessible and easy to interpret.	☐	☐	☐	☐	☐	☐
I understand what the map is showing.	☐	☐	☐	☐	☐	☐

4. Attitude Testing

Using the five-point scales below, indicate the point that best represents your attitude towards the map.

Helpful					Hindering
☐	☐	☐	☐	☐	
Entertaining					Boring
☐	☐	☐	☐	☐	
Interested to use					Not interested to use
☐	☐	☐	☐	☐	
Well-organised					Poorly organised
☐	☐	☐	☐	☐	
Elegant					Drab
☐	☐	☐	☐	☐	
Innovative					Conventional
☐	☐	☐	☐	☐	
Shows Likert responses clearly					Shows Likert responses poorly
☐	☐	☐	☐	☐	
Easy to understand					Difficult to understand
☐	☐	☐	☐	☐	

Now that you have finished your evaluation, please move on to the next genre of Likert innovation, being the Likert Radar Map of Attachment to Place.

Likert Radar Map of Attachment to Place (1)

The next type of Likert innovation presents all six survey questions as data representations called Radar Charts (also known as Spider Charts). These graphs use the average response to present the results for each question and are arranged by DCP. For reference, the six Likert survey questions are listed in the Welcome! section of this handbook and responses follow the Likert Scale of 1 (Strongly Disagree) to 5 (Strongly Agree) accordingly.

Please start with the Likert Radar Map titled “ESRI Streets Basemap with charts detailing question number” and complete the following tasks.

1. Starter Activity: Determining the Use of a Map

The purpose of this activity is to initiate your engagement with the map innovation and ensure that you can read the provided maps accordingly.

Please answer the following questions:

- a) What does the chart at DCP3 tell us about the response from the sample?

- b) Are there are geographical trends or patterns in the data, such as clusters of high or low Likert ratings?

- c) Are the Likert response patterns similar or do they differ across the research location?

Using the scale below, please indicate your initial impression of the Likert innovation map:

N/A	Very Poor	Poor	Average	Good	Excellent
☐	☐	☐	☐	☐	☐

2. Task-Based Testing

The following three tasks have been identified and designed to test how you as map users explore the data, looking for similarities and differences, interpreting findings and observing the patterns and trends within each Likert map.

Please answer the following questions:

- a) Locate the data collected at DCP1 on Prebends Bridge. What is the lowest average Likert response presented?
- b) From the data collected, which DCP shows the lowest recorded average for question e) “I know Durham really well.”
- c) Look at the results presented for question b) “This landscape reminds me of past times and brings back memories” across Durham. Briefly summarise the presented results.

3. Design and Aesthetic Testing

This activity is split into three parts: map style, legend design and symbology and representation. As each map has slightly different design principles and characteristics, you are now going to rank your thoughts about each. You can then provide further detail and justification for your answers in the focus group. Using the Likert scales below, please indicate the most appropriate response that corresponds to the provided statement:

	N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Likert Scale:	0	1	2	3	4	5
<i>Map Design</i>						
The basemap is clear and effective.	☐	☐	☐	☐	☐	☐
The arrangement of the map contents (i.e., legend, title, scale bar, etc.) are suitably placed.	☐	☐	☐	☐	☐	☐
The map is visually appealing.	☐	☐	☐	☐	☐	☐
The map is easy to use and interpret.	☐	☐	☐	☐	☐	☐

The radar charts are an effective type of representation.	☐	☐	☐	☐	☐	☐
<i>Symbology and Representation</i>						
The line formatting is effective and communicates the findings well.	☐	☐	☐	☐	☐	☐
The axis labelling on each chart is useful and effective.	☐	☐	☐	☐	☐	☐
The data representations (i.e., radar charts) are clear and easy to read.	☐	☐	☐	☐	☐	☐
The information is accessible and easy to interpret.	☐	☐	☐	☐	☐	☐
I understand what the map is showing.	☐	☐	☐	☐	☐	☐

4. Attitude Testing

Using the five-point scales below, indicate the point that best represents your attitude towards the map.

Helpful					Hindering
☐	☐	☐	☐	☐	
Entertaining					Boring
☐	☐	☐	☐	☐	
Interested to use					Not interested to use
☐	☐	☐	☐	☐	
Well-organised					Poorly organised
☐	☐	☐	☐	☐	
Elegant					Drab
☐	☐	☐	☐	☐	
Innovative					Conventional
☐	☐	☐	☐	☐	
Shows Likert responses clearly					Shows Likert responses poorly
☐	☐	☐	☐	☐	
Easy to understand					Difficult to understand
☐	☐	☐	☐	☐	

Now that you have finished your evaluation of the “ESRI Streets Basemap with charts detailing question number”, please move on to the next file titled “ESRI Streets Basemap with charts detailing question description”. Complete the following tasks.

Likert Radar Map of Attachment to Place (2)

Alike the previous, this type of Likert innovation presents all six survey questions as data representations called Radar Charts (also known as Spider Charts). These graphs use the average response to present the results for each question and are arranged by DCP. For reference, the six Likert survey questions are listed in the Welcome! section of this handbook and responses follow the Likert Scale of 1 (Strongly Disagree) to 5 (Strongly Agree) accordingly.

Turning your attention to the “ESRI Streets Basemap with charts detailing question description”, complete the following tasks below.

1. Starter Activity: Determining the Use of a Map

The purpose of this activity is to initiate your engagement with the map innovation and ensure that you can read the provided maps accordingly.

Please answer the following questions:

- a) What does the chart at DCP6 tell us about the response from the sample?

Using the scale below, please indicate your initial impression of the Likert innovation map:

N/A	Very Poor	Poor	Average	Good	Excellent
☐	☐	☐	☐	☐	☐

2. Task-Based Testing

The following three tasks have been identified and designed to test how you as map users explore the data, looking for similarities and differences, interpreting findings and observing the patterns and trends within each Likert map.

Please answer the following questions:

- a) Locate the data collected at DCP4 on North Bailey. What is the highest average Likert response presented?
- b) From the data collected, at which DCP did participants feel the least strongly about “Family Ties” in Durham?

- c) Observing the pattern of results for “Spend More Time Here”, briefly summarise the presented results.

3. Design and Aesthetic Testing

This activity is split into three parts: map style, legend design and symbology and representation. As each map has slightly different design principles and characteristics, you are now going to rank your thoughts about each. You can then provide further detail and justification for your answers in the focus group. Using the Likert scales below, please indicate the most appropriate response that corresponds to the provided statement:

	N/A	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Likert Scale:	0	1	2	3	4	5
<i>Map Design</i>						
The basemap is clear and effective.	☐	☐	☐	☐	☐	☐
The arrangement of the map contents (i.e., legend, title, scale bar, etc.) are suitably placed.	☐	☐	☐	☐	☐	☐
The map is visually appealing.	☐	☐	☐	☐	☐	☐
The map is easy to use and interpret.	☐	☐	☐	☐	☐	☐
The radar charts are an effective type of representation.	☐	☐	☐	☐	☐	☐
<i>Symbology and Representation</i>						
The line formatting is effective and communicates the findings well.	☐	☐	☐	☐	☐	☐

The axis labelling on each chart is useful and effective.	☐	☐	☐	☐	☐	☐
The data representations (i.e., radar charts) are clear and easy to read.	☐	☐	☐	☐	☐	☐
The information is accessible and easy to interpret.	☐	☐	☐	☐	☐	☐
I understand what the map is showing.	☐	☐	☐	☐	☐	☐

4. Attitude Testing

Using the five-point scales below, indicate the point that best represents your attitude towards the map.

Helpful					Hindering
☐	☐	☐	☐	☐	
Entertaining					Boring
☐	☐	☐	☐	☐	
Interested to use					Not interested to use
☐	☐	☐	☐	☐	
Well-organised					Poorly organised
☐	☐	☐	☐	☐	
Elegant					Drab
☐	☐	☐	☐	☐	
Innovative					Conventional
☐	☐	☐	☐	☐	
Shows Likert responses clearly					Shows Likert responses poorly
☐	☐	☐	☐	☐	
Easy to understand					Difficult to understand
☐	☐	☐	☐	☐	

You have now finished the usability testing for the third and final map group, “Likert Radar Map of Attachment to Place”. Please complete the final task ‘Cartographic Preference’ and read over the Usability Testing conclusion and debrief.

Cartographic Preference

Now that you have finished your independent review of each Likert innovation, please identify which map is your favourite and least favourite of the collection. Please note the reasons for your choices and we will discuss these further in the focus group session.

Favourite Map:	
Reason(s):	

Least Favourite Map:	
Reason(s):	

To Conclude and Debrief

Congratulations!

You have now completed the Usability Testing Handbook.

What I want to find out from this research project is how cartographic representations (i.e., maps) can be used to present people's emotions, feelings, and responses. Within my research, I argue that data visualisations can be used to explore the relationships between people and place. By mapping intangible, qualitative information in relation to the geographical location, it is possible to visualise these connections. I investigate how best to do so by creating data representations that communicate qualitative data in more innovative ways.

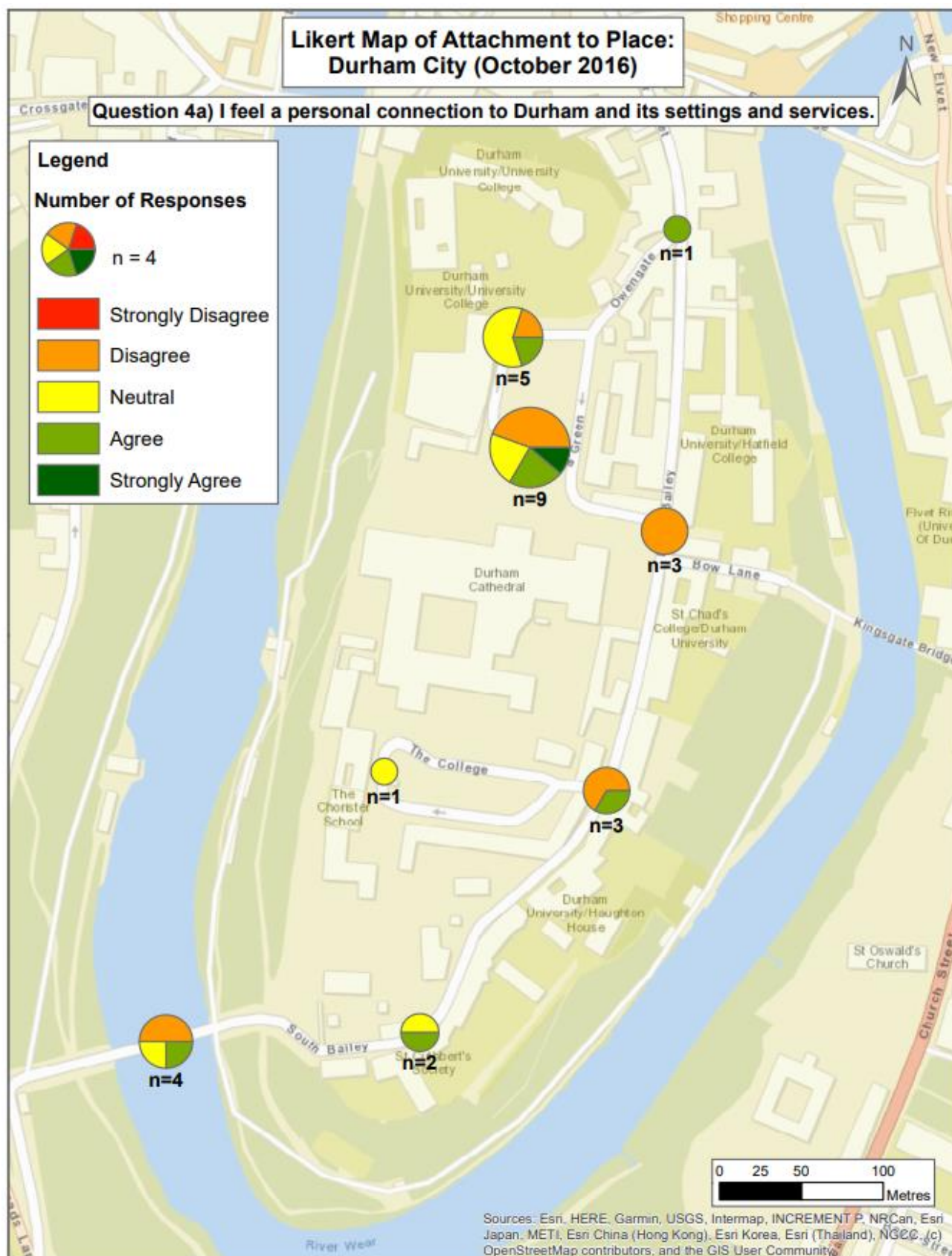
In this case, I am interested in finding out the usability and effectiveness of such data representations. Using my newly designed maps, with your input it is possible to consider their usability and how these maps may be improved to effectively communicate their message. Your thoughts and ideas about the various maps, your understanding of the representations, their strengths, weaknesses, and any potential changes, will help me to develop these data representations further and make necessary improvements.

Please send your completed handbook to me at the below email address, prior to attending the online focus group. If you would like further information about the study or would like to know what my findings are when all the data has been collected and analysed, then please contact me on isabel.h.williams@durham.ac.uk . I cannot, however, provide you with your individual results.

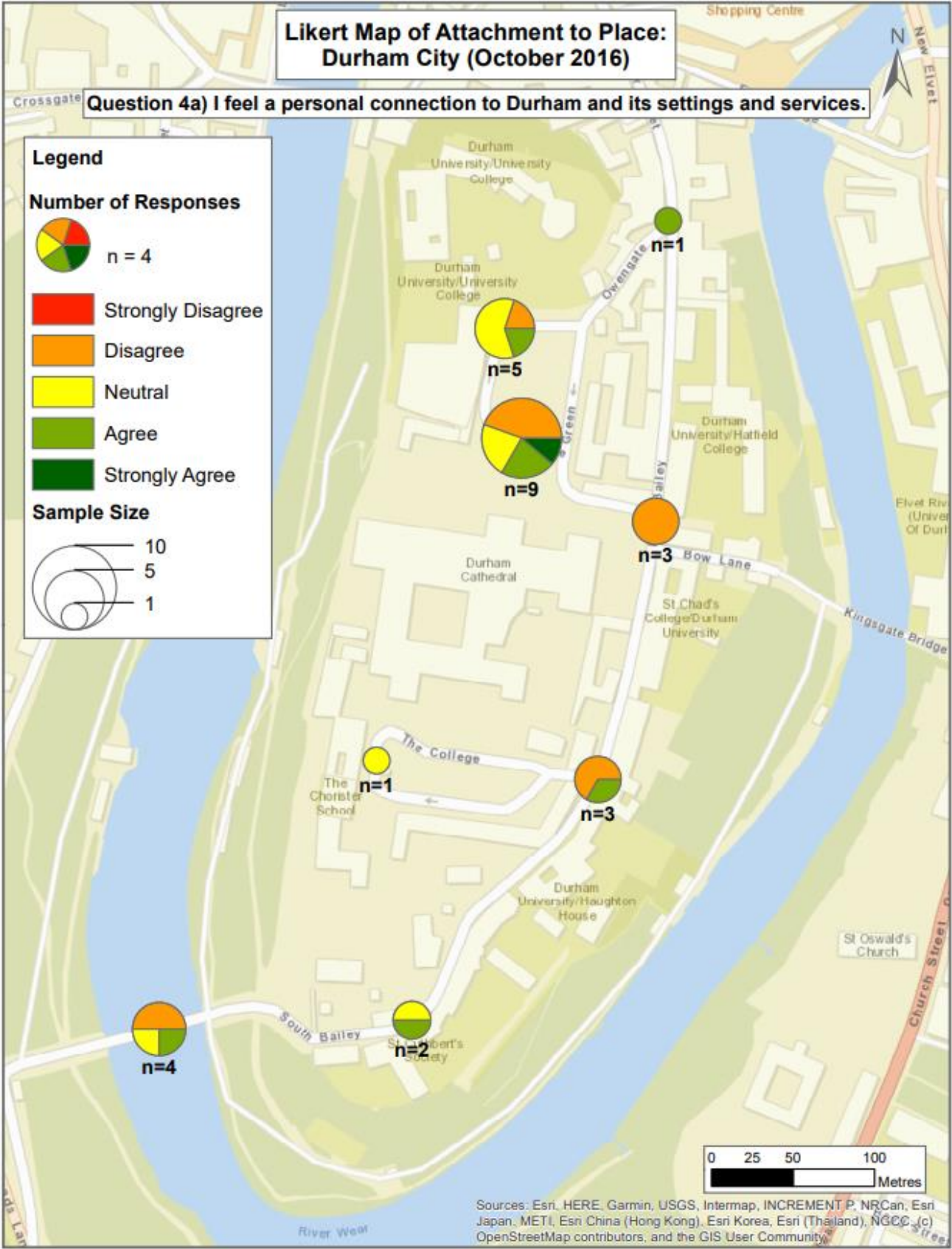
Thank you very much for taking part and giving your time to contribute towards the study.

Appendix F- Focus Group Project on Map Usability: Maps

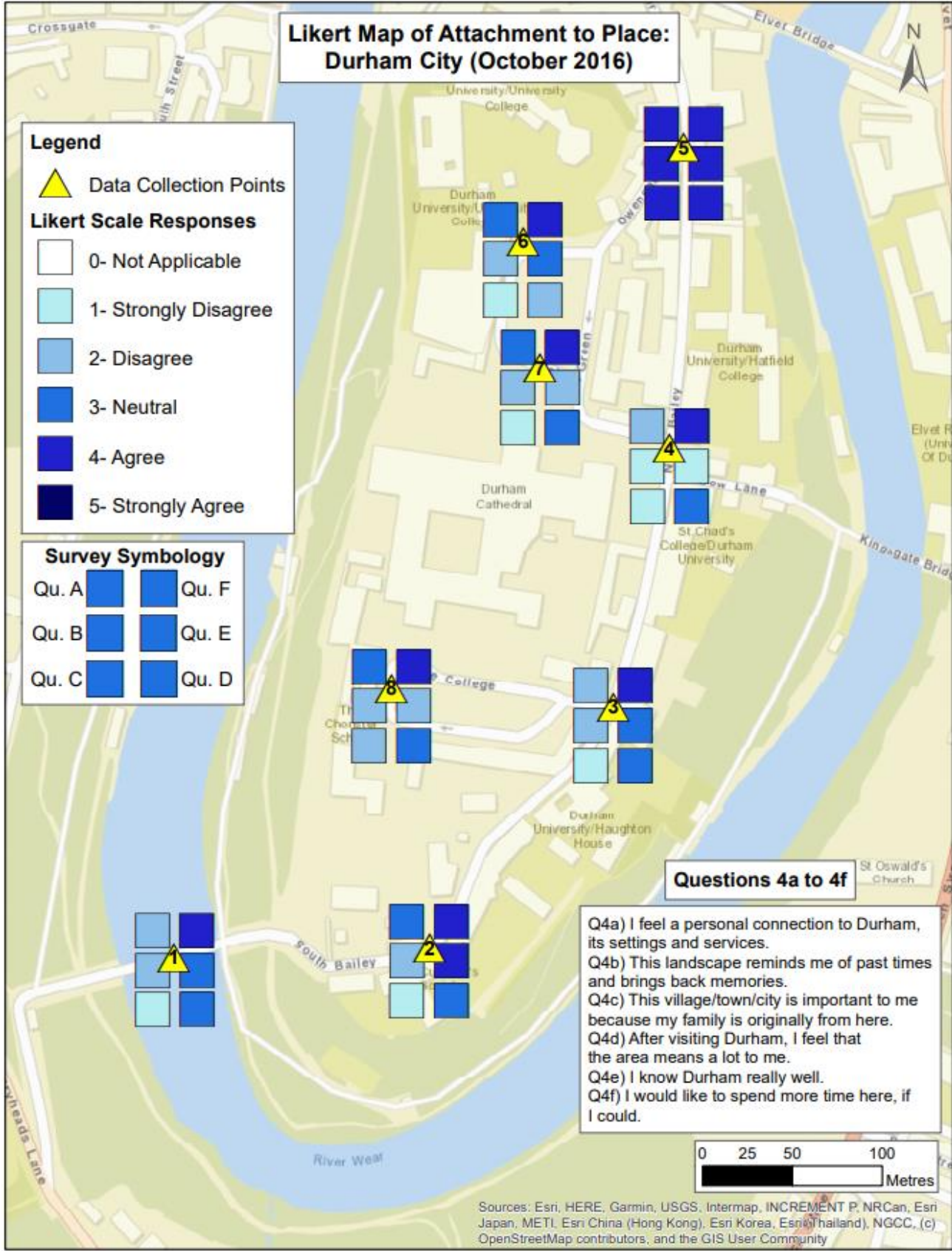
Likert Pie Chart Map: ESRI Streets Basemap



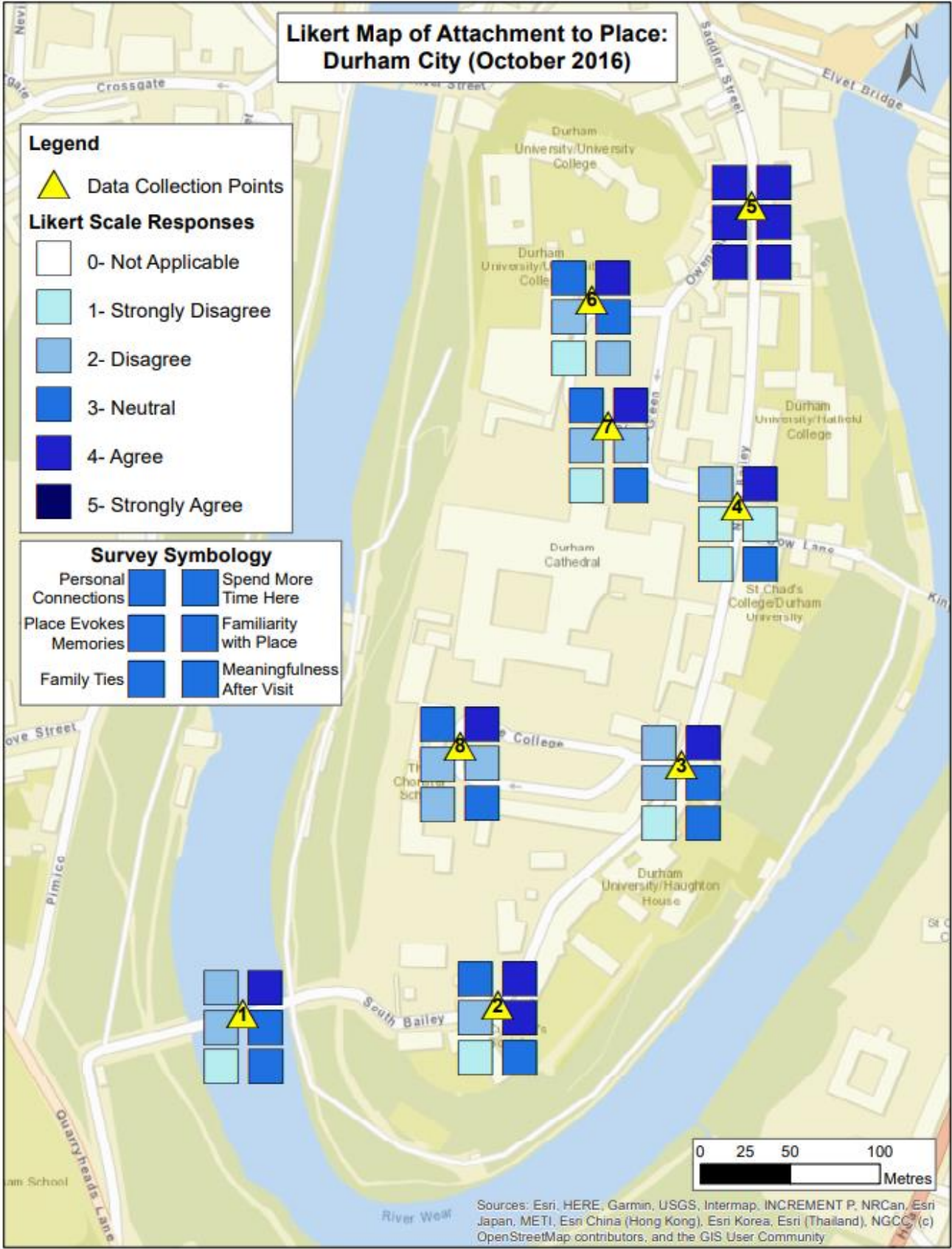
Likert Pie Chart Map: ESRI Streets Basemap Nested Legend



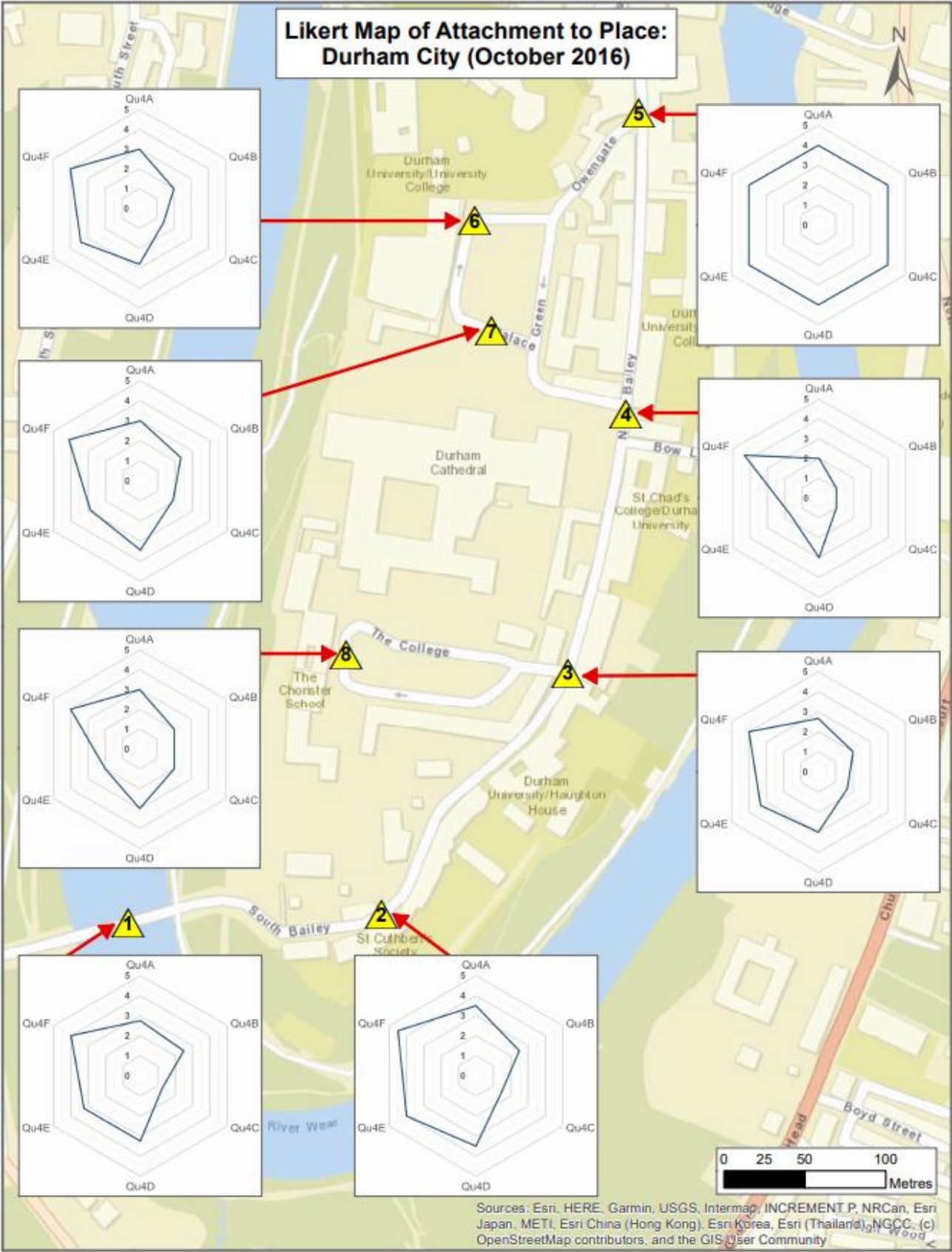
Likert Grid Map: ESRI Streets Basemap with Questions Outlined



Likert Grid Map: ESRI Streets Basemap without Questions Outlined



Likert Radar Map: ESRI Streets Basemap with Charts Detailing Question Number



**Likert Map of Attachment to Place:
Durham City (October 2016)**

Locations marked on the map:

- 1. South Street
- 2. St Cuthbert's
- 3. Durham University/Haughton House
- 4. St Charles College/Durham University
- 5. Oxencliff
- 6. Durham University College
- 7. Palace Green
- 8. The College

Attachment Likert Scale Categories (1-5):

- Personal Connections
- Spend More Time Here
- Place Evokes Memories
- Family Ties
- Meaningfulness After Visit

Scale: 0 25 50 100 Metres

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Appendix G- Participant Debriefing Sheet*

*Official copies of these documents are on university headed paper.

Project Title: Investigating Map Usability

Thank you very much for taking part in this study.

What I want to find out from this research project is how cartographic representations (i.e., maps) can be used to present people's emotions, feelings, and responses. Within my research, I argue that data visualisations can be used to explore the relationships between people and place. By mapping intangible, qualitative information in relation to the geographical location, it is possible to visualise these connections. I investigate how best to do so by creating data representations that communicate qualitative data in more innovative ways.

In this case, I am interested in finding out the usability and effectiveness of such data representations. Using my newly designed maps, with your input it is possible to consider their usability and how these maps may be improved to effectively communicate their message. Your thoughts and ideas about the various maps, such as your understanding of the representations, their strengths, weaknesses, and any potential changes, will help me to develop these data representations further and make necessary improvements.

If you would like further information about the study or would like to know about what my findings are when all the data have been collected and analysed then please contact me on isabel.h.williams@durham.ac.uk . I cannot however provide you with your individual results.