Chapter 32

Using Contemporary and Historical Census Data to Explore Micro-scale Population Change in Parts of London

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Abstract

The conduct of the latest population census in Britain in 2011 and the passage of 100 years allowing release of enumerator's records from the 1911 Census together offer an unprecedented opportunity for examining patterns of local-scale demographic and socio-economic differentiation and change over time. However, it remains impossible to examine these types of differentiation at the household, address and individual scales other than by means of modelling census data with information from sample surveys. This chapter reports on research that has captured and georeferenced historical census records from the 1901 and 1911 Censuses to their residential addresses in a sample of areas of the old London and Middlesex counties. The persistence or otherwise of geodemographic patterns has been explored by combining and aggregating these historical records with contemporary aggregate census data. Starting with an introduction that compares historical and modern censuses in terms of their conduct, content and geographies, this chapter examines the methods employed to geocode historical census records to current georeferencing systems. Using selected examples of social and demographic attributes common to censuses over this 100 year period, the results of analysis aggregating historical census records to 2001 and 2011 output area boundaries are presented. The chapter concludes by heralding the potential for future research combining historical and contemporary census data as the twenty-first century unfolds, but also cautions whether possible changes to the ways in which censuses are conducted and their very existence will prevent social science researchers from undertaking equivalent studies 100 years from now.

32.1 Introduction

Most chapters in this book focus on the British 2011 Census of Population or on similar but not identical enumerations that took place over recent decades (see for example, Chapter 30). Others look forward to an unfamiliar statistical landscape prevailing after a mainly online census in 2021 and a world in which a range of administrative and commercial data sources may, alone or in conjunction with a survey 'not totally unlike' the traditional census, hold sway (see for example, Chapter

33). It will not have escaped the reader's attention that, before the 2021 Census takes place, which may be the last such full-scale enumeration conducted with the comprehensiveness and completeness familiar to many census analysts, we will celebrate the hundredth anniversary of the 1920 Census Act. This established the legal framework for subsequent enumerations during the twentieth and early twenty-first centuries and still constitutes the primary legislation governing modern censuses.

The present chapter, in contrast to most others in this volume, unashamedly steps further back in time to the last two British population censuses that were held before the 1920 Census Act came into force and combines information from these with contemporary census data from the 2001 and 2011 enumerations. This serves not only to enable investigation of the persistence or otherwise of socio-demographic characteristics but also to reveal different types of analysis that can be carried out when georeferenced household and individual census data are available. The Censuses in 1901 and 1911 may be viewed as the culmination of incremental development in the administrative formality, topical coverage and recording accuracy of the British census during the nineteenth century. Censuses in the early decades of the 1800s were essentially head counts, which evolved into increasingly more comprehensive enumerators' books from 1841 onwards as the value of statistics for an expanding bureaucracy, particularly toward the end of the nineteenth century became more apparent. The release of the historical records from the 1901 and 1911 Censuses under the 100 years rule by The National Archives (TNA) has fuelled enthusiasm for genealogical research by individuals seeking to explore their ancestry. Information from these sources has also contributed to popular television programming, helping to find potential beneficiaries from people dying intestate and for portraying social and economic history through the ancestry of celebrities. The access route to these historical census records initially entailed consultation of the original paper documents, although more recently TNA has established partnerships with commercial organisations to provide access to scanned digital images and transcriptions of the sources.

Researchers of economic and social history have not neglected this rich source of information about the conditions of households and individuals during the Victorian and Edwardian eras and followed the lead set by Anderson's early work

transcribing a national one-stage cluster sample comprising a stratified 2% systematic sample from the enumerators' records of the 1851 Census (Anderson and Collins, 1973; Anderson, Collins and Stott, 1977; Anderson, 1987), yielding some 415,000 sampled individuals in 945 clusters. Enumerators' books were the sample units, selected on a one in 50 basis, except for settlements in England and Wales with a population less than 2,000, which were sampled as a whole. This initiative set a course navigated by subsequent researchers, who have captured cross-sectional census records for single settlements; for example, Tilley and French (1997) in respect of linking the 1851, 1861, 1871 and 1891 Census enumerators' returns for Kingston upon Thames and others who have focused on comparing urban or rural areas (Hinde, 1985). More recently the Integrated Census Microdata project at the University of Essex (Higgs *et al.,* 2013) in conjunction with a commercial partner findmypast.co.uk (part of bright solid) has created a resource of all historical British census records covering the enumerations from 1851 to 1911.

Historians have not surprisingly paid rather less attention to the geographical component of nineteenth and early twentieth century censuses than geographers when undertaking research with these data sources. Geographers have pursued two main directions in their research. The first, reflecting the growing importance of Geographical Information Systems and Science (GISS) in the visualisation and analysis of contemporary census statistics, has focused on capturing and harnessing historical data, especially boundaries and aggregate statistics, in order to examine long-term changes in population characteristics (see, for example, Gregory, 2002; Gregory *et al.,* 2001; 2002). The second has pursued the assembly of different types of data, including not only statistical information, but also pictorial images, historical maps, personal narratives, newspaper accounts and administrative records, into a multimedia database. Perhaps the most notable example of such a rich source of historical information in the British Isles is the *Vision of Britain*[1]*,* created from the Great Britain Historical GIS Project (Southall, 2003; 2006; 2014).

In the context of the present volume, this chapter seeks to provide an overview of the data sources, methods and some indicative findings that may be obtained from combining and co-analysing historical and contemporary census data with reference to a case study locality. The following two sections first review the

[1] http://www.visionofbritain.org.uk/

census and other data sources used in this research and then proceed to outline the method used to georeference the early twentieth century census records. The fourth section presents some indicative results of the analysis before a concluding section giving consideration to the wider implications of the work. In particular, the potential difficulties that may arise for future researchers are considered should something akin to the familiar census records not be available in 100 years time.

32.2 Data sources

The essence of the census research application outlined in this chapter involved the combination or integration of historical and contemporary geospatial and census data sources within a GISS framework. The aim was to georeference household and individual census records to the addresses where people were enumerated in the 1901 and 1911 enumerations. This corresponds to the population present household base used until the 1971 Census, which counted people where they happened to be on census night rather than where they usually lived. Georeferencing of these occupied 1901 and 1911 Census addresses would then offer opportunities to undertake enhanced analyses of the census data that incorporated a significant geographical component as well as allowing other historical sources to be incorporated in order to enrich our understanding of spatial variation in demographic, economic and social conditions. It must be acknowledged that the topical scope of the early twentieth censuses was considerably more limited than those undertaken in 2001 and 2011. Nevertheless, some core variables or attributes are present, albeit defined in different ways, in both pairs of censuses at the start of each century.

There has been a notable increase in the range and scope of datasets available to researchers through services supported by higher education and research funding, such as the UK Data Service and its predecessors, by governmental and public sector bodies, by commercial organisations, such as findmypast.co.uk in respect of a range of historical sources and by groups, for example local history societies, and occasionally individuals working on a formal or informal basis to capture the past and present conditions of their local communities. Data quality remains an important issue for academic researchers, especially when using information from what might be referred to as ‘voluntary sector maintained’

internet sites, although cross-referencing or triangulation between different sources can provide reassurance over quality. The following subsections review data sources used in this research application under two headings in relation to the time periods to which they relate: late nineteenth and early twentieth century; and early twenty-first century. Discussion focuses on data relating to England in view of the location of the selected case study areas (see section 32.3).

Late nineteenth and early twentieth century

The Census held on 31 March/1 April 1901, the eleventh decennial census in England and Wales, introduced a number of important changes to preceding enumerations, especially with regard to procedures for collecting data from households and from people residing in institutions or on vessels, and with respect to the publication of statistics, notably the addition of county reports including tables for parishes, boroughs, sanitary divisions and registration districts. Ten years later, the Census on 2/3 April 1911 collected data on a number of additional matters relating to issues that were topical at the time. Table 32.1 details topics included in each of these censuses and reveals close agreement in a number of respects, but also differences including a survey of married women's fertility, the nationality of people born outside Britain and industry of employment, which was likely to be connected with implementing measures under the 1911 National Insurance Act that provided unemployment benefits.

Table 32.1 Topics included in 1901 and 1911 British censuses in England

Addressed to:	**1901**	**1911**
Households	Address	Address
	Number of rooms if less than 5	Number of rooms
		Building type
Individuals	Name	Name
	Relationship to head of family	Relationship to head of family
	Marital status	Marital status
	Age	Age
	Sex	Sex
	Occupation	Occupation
	Birthplace (level of geographical detail sought depended on whether birthplaces was in England, Wales, Scotland/Ireland, British colony or dependency or a foreign country.	Birthplace (level of geographical detail sought depended on whether birthplaces was in England, Wales, Scotland/Ireland, British colony or dependency or a foreign country.
	Medical disabilities (deaf, deaf/dumb, blind, lunatic, imbeciles	Medical infirmities (deaf, deaf/dumb, blind, lunatic, imbeciles

	and the ‘feeble-minded’)	and the ‘feeble-minded’)
		Marital fertility (total live births to women in their present marriage, number still alive and number who had died)
		Age at marriage
		Nationality of people born outside of the country
		Employment status
		Whether working at home
		Industry or service of employment

The documents from these (and earlier) censuses were passed for preservation to the Public Records Office, the predecessor of TNA, and became available for public consultation 100 years after the census. The preservation of such historical documents raises issues over their curation and storage and a proportion of records in any given collection may suffer a degree of deterioration as time passes, for example as a result water or fire damage leading to the paper becoming increasingly fragile. Expansion of the internet acted as a stimulus to the establishment of organisations offering subscription services allowing access to scanned images of these public documents and transcriptions of the recorded information. The scanned records offer the possibility of arresting further deterioration of the paper records provided adequate measures for their retention, preservation and continued accessibility are implemented. Table 32.2 provides transcriptions of the census records for a family that lived in the same house at the time of the 1901 and 1911 Censuses. A second child was born during this decade and the head of the household remained working in the same occupation as a tapestry weaver. This example illustrates the potential for enhancing the information recorded in the 1901 Census documents, because it may be inferred the husband and wife had been married four years at that time, they occupied five rooms and the head of household was a worker.

Table 32.2 Transcriptions of 1901 and 1911 census records for linked household and individuals

1901										
Schedule number	House number/name, road/street name	Number of rooms if less than 5	Name and surname	Relationship to head of family	Condition as to marriage	Sex	Age last birthday	Profession or occupation	Birthplace	If: (1) deaf and dumb, (2) blind, (3) lunatic or
61	Ivy Cottage, Park Road	-	John Martin	Head	Married	Male	29	Aras Tapestry weaver	Middx: Hampton Wick	-
			Louisa Martin	Wife	Married	Female	26	-	London: Stepney	-
			William Martin	Son	-	Male	3	-	Middx: Hampton Wick	-

1911										
					Age and sex	Particulars of marriage		Profession or occupation		

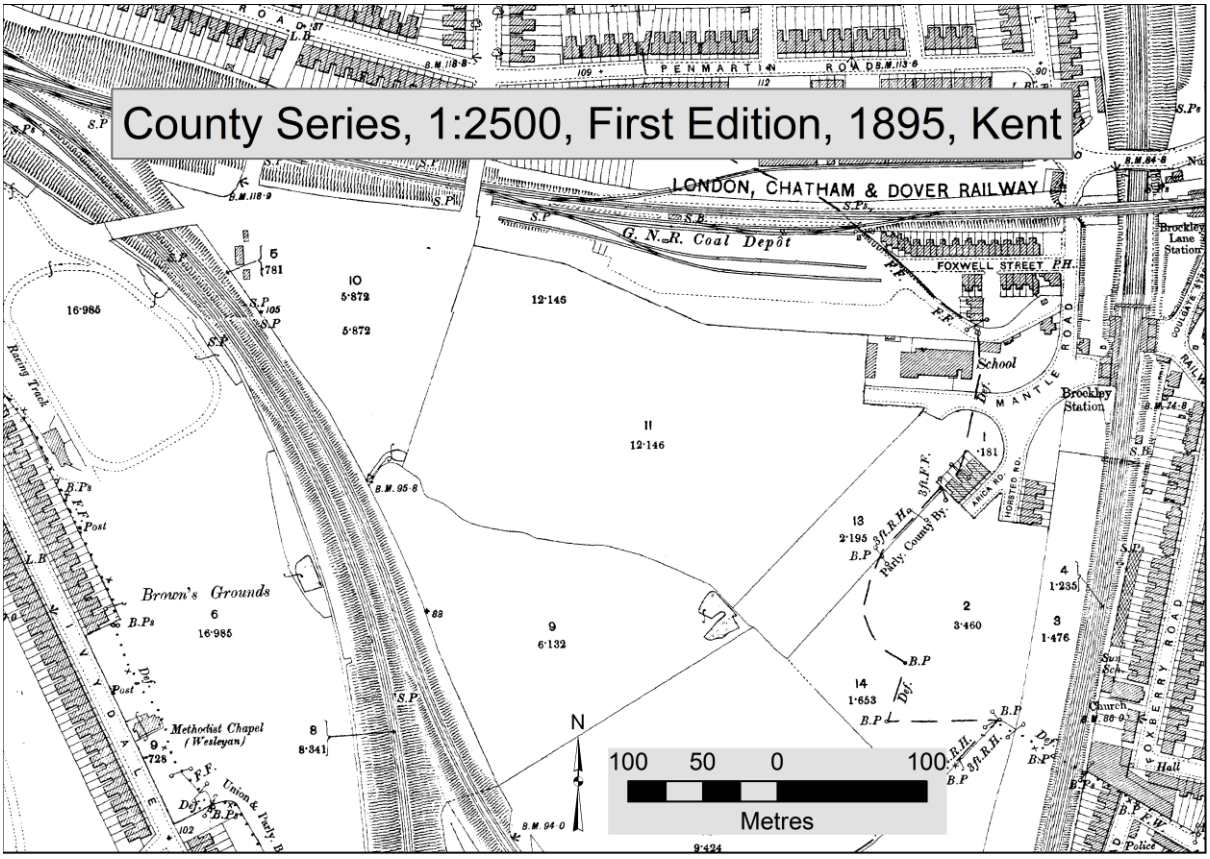
Schedule number	House number/name, road/street name	Number of rooms	Name and surname	Relationship to head of family	Male	Female	Marital status	Completed years of present marriage	Total children born alive	Children still living	Children who have died	Personal occupation	Industry or service	Employment status	Whether working at home	Birthplace	Nationality for persons born in foreign country	If: (1) deaf and dumb, (2) blind, (3) lunatic or (4)
176	Ivy Cottage, Park Road	5	John Martin	Head	39		Married	-	-	-	-	Aras Tapestry weaver	-	Worker	No	Middlesex Hampton Wick	-	-
			Louisa Martin	Wife		36	Married	14	2	2	-	-	-	-	-	London: Stepney	-	-
			William Martin	Son	13		-	-	-	-	-	-	-	-	-	Middlesex: Hampton Wick	-	-
			Doris Martin	Daughter		4	-	-	-	-	-	-	-	-	-	Middlesex: Hampton Wick	-	-

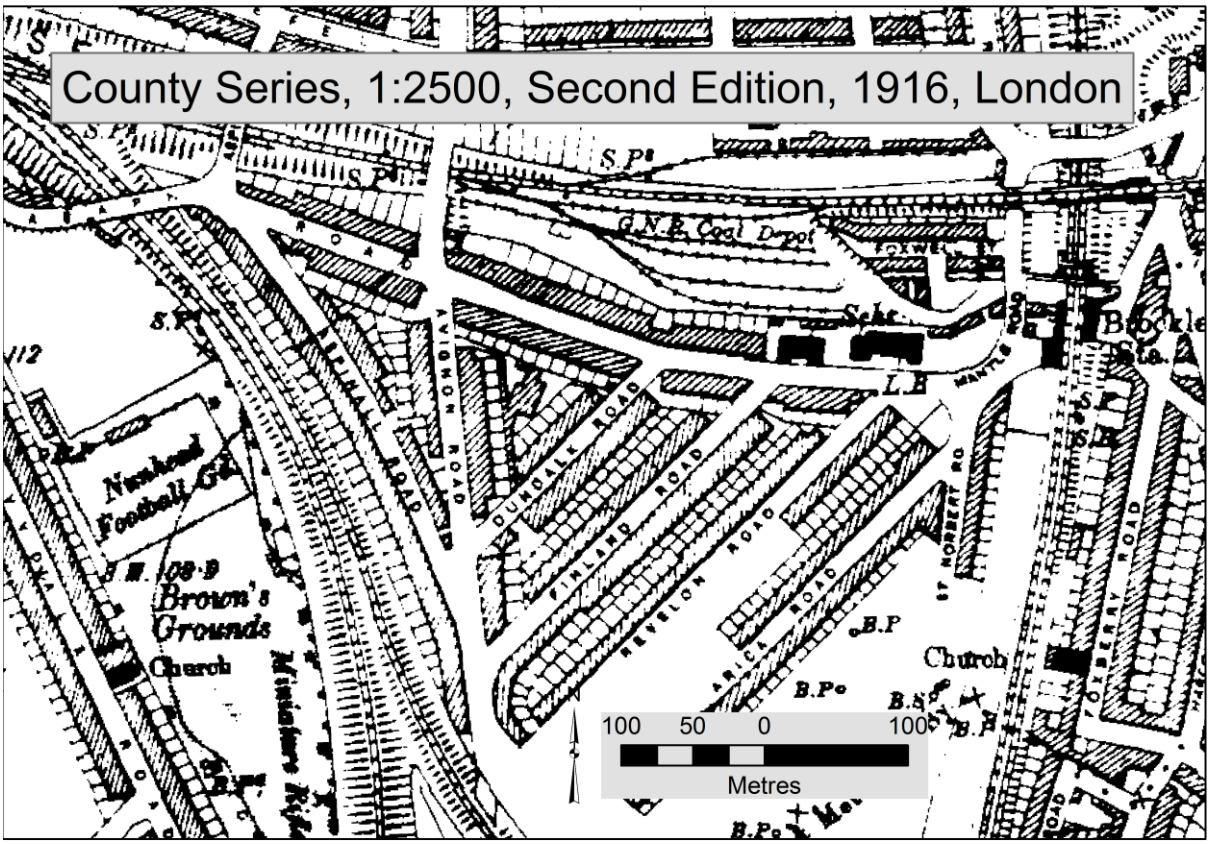
Source: TNA RG13/671/174/9; RG14/3568/357/1

Note: dashes (-) denote blank entries on the census record indicating not applicable; household level data have not been duplicated for individuals.

The Ordnance Survey embarked on producing the County Series of topographic maps at the six inch mapping scale (1:10,560) in 1840 and in 1854 expanded this to include mapping at 1:2,500 (approximately 25 inches to the mile) in order to meet the need for greater detail. The first editions of maps at both scales for the whole country were published by the 1890s and surveying for the first revision commenced in 1891. This was completed shortly before the First World War and re-surveying for a third or second revision started in 1907 and continued until the 1940s, although it was never completed and only areas with significant changes were revised (Harley, 1975). The Ordnance Survey and Landmark Information Group created scanned digital copies of these historical maps, which are available through Edina. The OS archive of historical maps was 93% complete when scanning started in 1995 at 300 dpi and both organisations sought to source the missing maps in order to achieve as complete coverage as possible. The scanned images were processed to conform to the National Grid and to create a tiled seamless mosaic across the country.

These scanned registered raster images provide background mapping that aids the process of georeferencing 1901 and 1911 Census addresses. Figure 32.1 provides an illustration of the land cover changes that were taking place at the turn of the twentieth century using the example of an area in Deptford, south east London. This area was part of Kent on the OS First Edition County Series map published in 1895 and shows that a few metres of Arica Road and St Norbert Road had been constructed and a few residential properties had been built along each (right of centre on upper map image). However, by 1916, when the Second Edition map was published these roads had been extended southwards and other roads (Aspinall, Avignon, Dundalk, Finland, Revelon and St Asaph) had been built over what were formerly open fields (note field number and areas on First Edition map) and seemingly were lined with mainly terraced residential properties. Each map shows some buildings were named, but neither provides details of the house numbers or names, which were included in the census records. The address of the transcribed census records in Table 32.2, Ivy Cottage, Park Road is not a named building on either the First Edition County Series sheet published in 1896 or the Second Edition published in 1913, although other properties on the road are named, for example Thatched Cottage and a Vicarage.





a. County Series, 1:2,500, First Edition, 1895, Kent
b. County Series, 1:2,500, Second Edition, 1916, London

Source: Landmark Information Group, Edina

Figure 32.1 Comparison of Ordnance Survey base topographic mapping for an area in Deptford, south east London

One further historical data source deserves mention before switching to examine the early twenty-first century mapping and census data sources that contributed to the research. Charles Booth's 'poverty map' was not used to assist with the georeferencing process, but is an example of an additional data source that can enhance analysis of the historical census records. Booth carried out a survey of people in London between 1886 and 1903 (Booth, 1902) and he published some of the results of his inquiry as an innovative example of social mapping in 1889. Such was the significance and interest in this first map that it was comprehensively revised 10 years later with a new classification of the surveyed streets. Known as the *Map Descriptive of London Poverty, 1898-9*, the mapping comprises 12 map sheets at the1:10,560 scale covering the area of the County of London from Hammersmith to Greenwich and Hampstead to Clapham. The maps were digitised and rendered searchable by the Charles Booth Online Archive project[2]. The Booth maps have been digitised so that they conform to modern standards of georeferencing and they were stitched together to create a single seamless image.

Early twenty-first century

One of the main differences between the historical and contemporary census data, at least from the users' perspective, is that the former are available as paper records or digitised images of the original documents from which data about individuals and households present at addresses can be captured. In contrast, contemporary census data, apart from the special case of the Samples of Anonymised Records, are cross-tabulated counts of one or more characteristics aggregated to spatial units of different sizes within nested hierarchies. Although these are generated dynamically with respect to the 2011 Census, users will not be able to access the complete set of household and individual records for a little under 100 years according to current legislation. However, as will become apparent in due course, one of the outputs from the research reported here are similar but inevitably less comprehensive aggregate statistics for both small historical units, for example 1901 and 1911 enumeration districts, and historical census data aggregated to modern spatial units.

[2] http://booth.lse.ac.uk/

Contemporary aggregate census data are accompanied by digital geospatial data corresponding to the boundaries of the spatial units enabling the statistical data to be mapped and visualised thematically. It is inappropriate to provide detailed information about the characteristics of the 2011 Census datasets as these are contained elsewhere in this volume or in equivalent texts published following the last three censuses (Rhind, 1983; Openshaw, 1995; Rees *et al.,* 2002). However, one point worth mentioning at this stage is that the high degree of consistency between the output area geography of the 2001 and 2011 Censuses (over 95%) means that it will be possible to aggregate the georeferenced historical census data to spatial units there also reasonably consistent between 1901 and 1911.

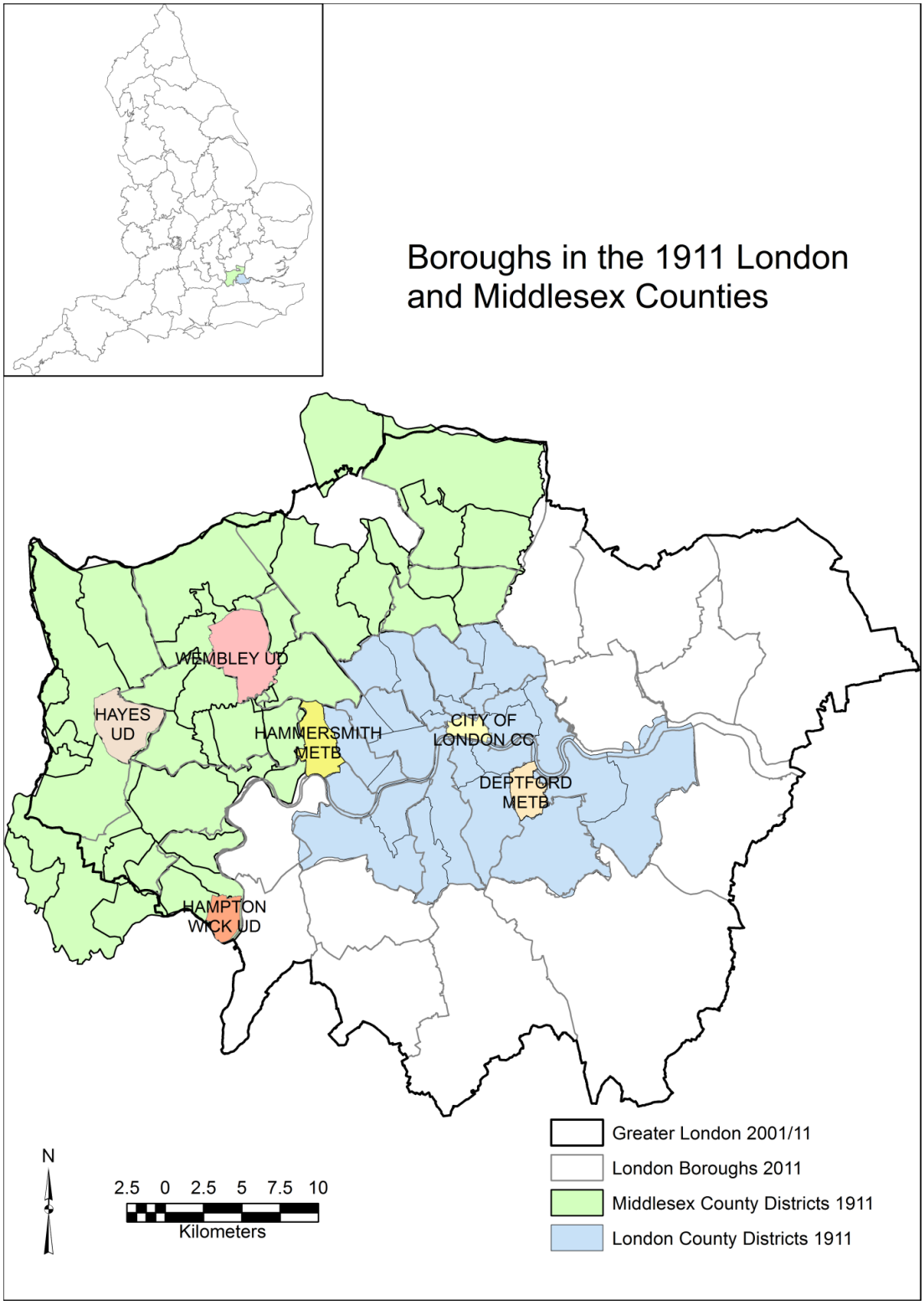
Modern topographic mapping comparable with the digitised images of historical OS maps are not relevant to georeferencing the 1901 and 1911 Census addresses. However, one of the most important data sources assisting with this process is the Address Layer 2 of the contemporary MasterMap data produced by the OS. Having been launched in 2001 following re-engineering of the LandLine data, OS MasterMap has become the organisation's main digital topographic mapping product, replacing LandLine in 2008. MasterMap consists of a series of layers (topography, integrated transport, address and imagery), some of which are subdivided into themes. Some of these data are available for research and teaching purposes to UK Higher Education institutions through the Digimap service at the University of Edinburgh. The locations of addresses, both postal and non-postal, are held in OS MasterMap Address Layer 2 (MMAL2). It includes not only the georeference of each address, but also fields relating to the postcode, building number and name, thoroughfare and unique Topographic Identifier (TOID).

32.3 Methods and analysis

The various historical and contemporary geospatial and census data sources examined in the previous section are, for the most part, available nationally in a reasonably consistent format and structure. However, embarking on developing a method for georeferencing addresses in the 1901 and 1911 Censuses was not something that could feasibly be undertaken on a national basis with the resources available. It was necessary to carry out a pilot study and to select areas that would

potentially demonstrate the feasibility of the method and provide some rewarding insights into demographic, economic and social conditions of Britain in the early twentieth century that could be compared and contrasted with the situation 100 years later.

The nineteenth century is often characterised as the period in which Britain's population transitioned from a largely land-based economy and society located for the most part in rural areas to an urban one centred on the burgeoning cities and towns founded on the 'factory system'. The population of England and Wales grew from 8.9 million in 1801 to 32.5 million in 1901 and by 1851 half of the population was regarded as 'urban'. Although much this urban industrialisation was focused on northern England and South Wales, these industrialising and urbanising processes permeated the length and breadth of the country and London was emerging as a centre of administrative and political, if not yet perhaps economic, power. London's population exceeded 4.5 million in 1901 with 0.8 million in the neighbouring county of Middlesex. By the close of the twentieth century, these areas had for the most part been absorbed into the Greater London Authority, which additionally had expanded eastwards and southwards to include areas in the former counties of Essex, Kent and Surrey (Figure 32.2). Estimating the 2011 population of the area approximately equivalent to Middlesex and London Counties suggests the 1911 total of 5,609,150 had increased to 5,646,558, which represents 69.1% of people in the GLA area as a whole, which now includes London Boroughs south and east of the two historical counties.



Source: Ordnance Survey, Edina

Figure 32.2 Case study boroughs and urban districts in former London and Middlesex counties in relation to present day Greater London Area

The specific details of the local government areas in place and the statutory functions for which they were responsible at the start of the twentieth century are very different from what exists today, although the principle of larger units containing smaller ones (counties and their constituent Metropolitan Boroughs (MB), County Boroughs, Urban Districts (UD) and Rural Districts) was already in place. Although a two-tier hierarchy currently occurs over much of England, restructuring over recent decades has eroded its existence everywhere. A group of 1911 MBs and UDs, three each from London and Middlesex counties, were selected for the purpose of developing and testing a method for georeferencing 1901 and 1911 Census addresses. These areas were selected to illustrate contrasting trends of population change 1901-11, to reflect different locations in relation to current inner and outer London and localities north and south of the River Thames. They were also chosen on the basis that the number of addresses to be georeferenced would be feasible with the resources available.

The six areas were the City of London (MB), Deptford MB and Hammersmith MB in London County and Hampton Wick UD, Hayes UD and Wembley UD in Middlesex County, which together had total populations of 258,821 in 1901 and 268,048 in 1911 (respectively 4.9 and 4.8% of their total person counts); and the equivalent figures for households were 57,823 and 61,369 (1901 and 1911) and for addresses 37,423 and 38,694 (again 4.9 and 4.8% of the total in both cases). This chapter for the most part focuses on the results for the 1911 district of Hammersmith, with reference the other five case study areas for the purpose of comparison. Hammersmith experienced population growth of 8.3% between 1901 and 1911, which compares with a modest fall of -0.3% across London County as a whole, making it the borough with the fourth highest upward growth over the decade.

It is obvious with the passage of more than 100 years between when the present research started in 2013 and the 1901 and 1911 Censuses that many of the addresses recorded in the historical censuses would not be present in modern georeferenced address data. Similarly many contemporary addresses would not have existed in the first decade of the twentieth century. The MasterMap Address Layer 2 (MMAL2) data are not routinely available to researchers through the Digimap service at the University of Edinburgh in large part because of their commercial value. However, they can be used under special licence. Street gazetteers were

produced for some areas around the turn of the twentieth century, including one of the sampled UDs in Middlesex (Wembley) (Wembley Urban District Council, 1906), but such information was not available comprehensively. Similarly, there are some local history societies that have created websites where the development of their settlement has been charted. Again, this has occurred in one of the sampled areas Hampton Wick in Middlesex, where the website[3] includes maps showing the residential and commercial properties on the relatively small number of thoroughfares comprising this settlement with a link to their historical census record and other information. The availability of such local sources on only a piecemeal, patchy basis prompted use of the MMAL2 as an initial starting point for georeferencing historical census addresses for the sampled areas, whilst recognising its limitations.

The method developed to match and georeference these addresses can be summaries as a four stage process:

1. Match addresses from transcribed 1901 and 1911 Census records and MMAL2 data; geocode joined spatial and attribute data; and create point features for addresses.
2. Examine visualisation of geocoded census addresses alongside MMAL2 addresses; and identify and correct anomalies (e. g. through road names changes).
3. Identify non-geocoded addresses from stages 1 and 2 and locate on historic map images; and manually digitise new points and transfer addresses from 1901 and 1911 Census data to additional points.
4. Create a unified file of matched spatial and census data for each set of households and individuals in 1901 and 1911.

Despite the increase in residential addresses between the 1901 and 1911 Censuses (see example in Deptford MB in Figure 32.1), the number of consistent addresses present in both sets of records was reasonably high. The process of matching census addresses to the MMAL2 records therefore started with 1911 and then worked backwards to 1901 to maximise the advantage arising from those addresses that were identical.

[3] http://www.brickbybrick.org

Figure 32.3 shows the different stages of the process and illustrates some of the issues that complicate the simple matching of MMAL2 with 1911 addresses in Hammersmith. The residential number or name captured from the census records and held in the MMAL2 data were converted into a standard format (e.g., 42 High Street or Oaklea Park Road) as an address field in each database before being matched using standard procedures. Approximately 57% of the 1911 Census addresses in Hammersmith were successfully matched at this stage representing 55% of individuals and 57% of households (Figure 32.3a).

a. Matched and digitised 1911 Census addresses in Hammersmith
b. Example of incorrectly transcribed road name (Jedds Road instead of Jedds Road)
c. Example of road name change (Rayleigh Road became Rayleigh Grove in MMAL2)
d. Example of redevelopment leading to MMAL2 addresses being unconnected with historical census addresses

Source: Ordnance Survey, Edina. © Crown copyright and/or database right 2016 OS

Figure 32.3 Application of address matching between 1911 Census addresses in Hammersmith and digitisation unmatched addresses

Stage 2 entailed careful examination of the mapped points overlain on the historical topographic map images in order to identify streets or groups of properties that seemed likely to be residential where matching with the MMAL2 address field had not occurred. This scrutiny was able to account for a proportion of the unmatched addresses either as a result of incorrectly captured census record addresses or changes in the name of the thoroughfare. Figure 32.3b shows the example of Jeddo Road, which appeared on the map image and in the MMAL2 data, but was incorrectly transcribed as Jedds Road. The second example in Figure 32.3c shows where mismatches arose from a change in the name of the thoroughfare from Rayleigh Road in the 1911 Census to Rayleigh Grove in MMAL2. Data editing and reapplication standard field comparison procedures enabled these addresses to be successfully matched and raised the proportion of georeferenced 1911 addresses in Hammersmith to 63%.

Stage 3 completed the georeferencing process by manually digitising the addresses that were still missing grid coordinates (Figure 32.3d). The location of these was achieved by a number of different means including use of local street gazetteers and websites (see examples previously mentioned), by examining the schedule numbers in the census records, which revealed that these generally run in a regular sequence along individual thoroughfares and by searching for property names on the historical topographic map images. There were 5,944 or 26% of 1911 addresses in Hammersmith that to be identified and digitised in this way. At the end of stage 3, the grid coordinates for all census addresses in each of the six case study areas had been obtained. Matching with the MMAL2 meant that as well as transferring the grid coordinates the unit postcode could also be allocated to the historical address. Addresses that were not matched in this way were assigned the postcode of the nearest known MMAL2 address. Further processing of these georeferenced address records enabled these grid references to be attached to the transcribed census data records of individuals and households. This allowed the analysis to proceed for both of types of social unit and to aggregate these records to

historical and contemporary spatial units (e.g. 1901 and 1911 enumeration districts, thoroughfares, and 2001 and 2011 output areas).

32.4 Then and now

This section offers an introductory selection of results from analysing the georeferenced historical census on their own and, perhaps more importantly in the context of this volume's focus on the 2011 Census, by aggregation to contemporary spatial units. Two aspects of the 1911 Census information for Hammersmith are explored in Figure 32.4. Georeferencing of the addresses enables the data to be aggregated to thoroughfares and for measures such as the number of persons per metre to be calculated (Figure 32.4a). Viewing Hammersmith Borough as a whole, it is clear that some streets were more densely populated than others. This type of micro-scale demographic analysis is taken a stage further in Figure 32.4b where the numbers of persons per address in a small part of the Borough are shown as graduated symbols superimposed on the historical topographic mapping. Both parts reveal some considerable variation in the density of population in 1911 in Hammersmith with dwellings of the same physical size and layout on individual streets having different numbers of people. Further analysis will explore the demographic and socio-economic composition of these streets and addresses in terms of the number of separate households, family structure, occupation, place of birth and childrearing.

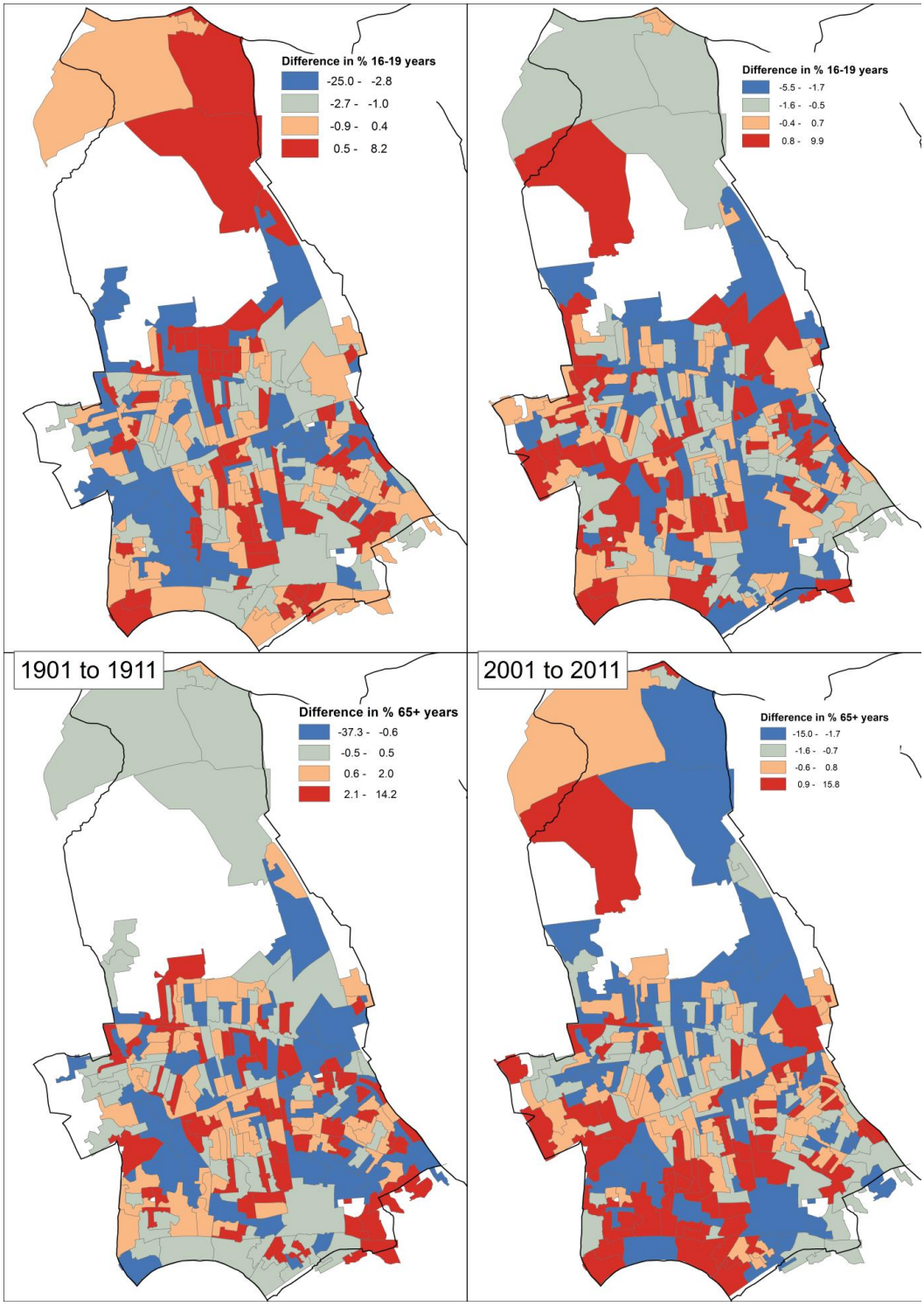
a. Aggregation to streets b. Analysis of address level data

Source: Ordnance Survey, Edina. © Crown copyright and/or database right 2016 OS

Figure 32.4 Examples of analyses of 1911 Census for streets and addresses in Hammersmith

The changing age structure of populations in developed countries has become an important issue for researchers and policy-makers in recent years and is most clearly articulated in concerns over population ageing and the consequent challenges; for example, in relation to health care and pension provision, for governments faced with a rising proportion older people in national populations. Exacerbating the issues associated with an ageing population in many countries is the now well established trend for low fertility in some cases at sub-replacement level. Figure 32.5 offers an introductory exploration of changes in the percentage of two age groups (16-19 and 65 and over) in Hammersmith during the first decades of the twentieth and twenty-first centuries. The 1901 and 1911 individual level census data were aggregated to the unaltered census output areas in Hammersmith in 2001 and 2011. Each map shows the difference in the percentage of one of the age

groups either between 1901-11 or 2001-11; maps a and c in Figure 32.5 relate to the first of the earlier period and maps b and d to the second. The maps for 2001-11 include nine output areas not shown on the 1901-11 maps which were unpopulated in either 1901 or 1911. Each of the maps uses quantile classification with dark blue shading indicating highest decrease in the age group and dark red greatest decrease. In each case the spatial distribution of these changes shows a degree of randomness, although further spatial autocorrelation analysis using Local Moran's I does reveal clustering of high-high and low-low values in some locations in both decades (Anselin, 1995).



a. % Change 1901-11, ages 16-19
b. % Change 2001-11, ages 16-19
c. % Change 1910-11, ages 65 and over
d. % Change 2001-11, ages 65 and over

Note: The maps for 2001-11 include nine output areas not shown on the 1901-11 maps which were unpopulated at that time. The quantile classification method has been used for each map.
Source: Ordnance Survey, Edina.

Figure 32.5 Examples of analyses involving aggregation of 1911 Census addresses in Hammersmith to modern output areas

32.5 Conclusions

The Census held on 27 March 2011 was the twenty-first complete enumeration of the population in Britain and throughout more than a 200 year history of census-taking changes have been introduced between each successive survey. One perspective on this history is that every census is a unique event reflecting both the economic and social conditions and the administrative and technological norms of its time. However, an alternative view is that the rigour and diligence applied to each enumeration argues for exploring the rich history of demographic, economic and social change that can be charted through careful exploration of different points in this longstanding series of cross-sectional population data. It would be foolhardy to argue that any census or perhaps even alternative assemblage of administrative and survey data, no matter how rigorously conducted, would be capable of achieving 100 per accuracy in its count of people and a selection of their attributes. At the extremes of people's life course, there will always be some births and deaths that are missed on the reference date, let alone failures in capturing all in- or out-migration.

The research outlined in this chapter has advanced one stage further the former historical investigations of census data by delving below the level of aggregate statistics to explore the opportunities arising from analysis of household and individual level historical census records georeferenced to the addresses where people were enumerated. These data reveal the geo-analytical possibilities offered to researchers from having available such a comprehensive database that are impractical with contemporary census data and from being able to explore the persistence or discontinuity in aggregate spatial differentiation over time. The method for georeferencing the historical census records outlined here has shown that it is feasible to use modern address databases to attach grid coordinates to historical addresses provided that sufficient supplementary information sources are available to help 'fill in the gaps'. One difference between the London County MB census addresses and those in the UDs in Middlesex when attempting to match with the MMAL2 is that a relatively high proportion of residential addresses on thoroughfares in Hampton Wick, Hayes and Wembley were identified by means of their names rather by numbers, although the actual property may be the same.

At a time when the future of census-taking is uncertain and despite the commitment to holding a mainly online census in 2021, it is important not to discard the possibility of undertaking long-term analysis and data matching of the type outline here as we progress through the twenty-first century and beyond. It is to be hoped that academic and genealogical researchers 100 years from now will not be denied the opportunity to explore their family histories and the detailed spatial variations that for reasons of confidentiality remain concealed from us as we investigate the demographic, economic and social conditions of early twenty-first century.

Acknowledgements

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