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ARTICLE

A geography of UK museums

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Abstract

Museums are important centres of heritage, culture, education, and tourism. These diverse institutions operate in different ways, reaching different audiences and managing varied collections. Thanks to a novel database of unprecedented completeness produced by the Mapping Museums project, this study provides a quantitative geography of museums in the UK, showing how about half of the sector had not been surveyed before. The presence of museums is mapped across several attributes, including museum size (estimated as yearly visits) and governance (government-led, independent, or university-led). Firstly, observing a snapshot of the sector in December 2017, we quantify and interpret the spatial distribution of museums, discussing its implications for access to museums, public service provision, resource allocation, and cultural tourism. Then, in a regional analysis, we study their density in relation to the local population, at the regional and Local Authority District scale, providing new evidence of the extent of spatial inequalities in the cultural sector, particularly relevant to a sector in which funding is mostly allocated at the regional level. At the crossing between human geography and museum studies, this inquiry reveals the centres and peripheries of this cultural sphere, providing fresh evidence of the presences and absences that shape cultural life across the UK.

KEYWORDS

museum analytics, museum geography, museum studies, quantitative geography, regional analysis, UK

1 | INTRODUCTION

Museums are a vital part of the British cultural and economic landscape, and have a crucial role in heritage, tourism, and education. In England alone, before the COVID-19 pandemic, museums attracted up to 100 million annual visits, with a turnover of £2.64 billion per annum (Association of Independent Museums, 2019; Tuck, 2015). While the public imagination about the sector is dominated by (and often reduced to) prominent national museums funded by the central government and attracting global audiences, such as the British Museum, other museums are vastly heterogeneous, both in terms of purposes, objects, funding mechanisms, and audiences, playing diverse roles. The Potteries Museum in Stoke-on-Trent is a large museum managed by a local authority and serves mostly local communities; The Black Watch

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Regimental Museum in Scotland is a medium-sized, not-for-profit, independent organisation focused on military history; The National Coracle Museum, by contrast, is a small private institution in Wales.

Understanding the spatial distribution of *all* museums matters to museologists, practitioners, and policymakers. Knowledge about where different kinds of museums are located can uncover patterns in inequalities in the distribution of cultural assets, access to museums, public service provision, resource allocation, and cultural tourism, providing empirical evidence for policy change. Conversely, a detailed mapping of museums enables the inference of new insights about their local contexts, purposes, and audiences, for example to study the effects of placemaking and cultural regeneration.

Knowledge about museums has been collected through a number of surveys by arms-length bodies and professional associations, such as Arts Council England and the Museums Association (Candlin et al., 2020a). However, because of shortcomings in the collection with respect to visitor numbers, workforce, funding, volunteering, and collections, the available quantitative datasets return a fragmented and partial picture of the sector (Mendoza, 2017), which tends to concentrate on museums in particular nations or regions, on museums that are recognised by the Arts Council Accreditation scheme, and only rarely examines the distribution of museums in relation to population density. Our recent research covers the UK as a whole, including accredited and unaccredited museums, thereby doubling the size of the study from around 1800 to about 3200 museums, and introduces nuance and detail to the analysis (Candlin et al., 2020a).

The geographic facets of museums and their spatialities have attracted attention in the social sciences and humanities, mostly through qualitative case studies centred on prominent museums. A museum is geographical both as a network of physical objects that include buildings and collections organised through architecture and design (Giebelhausen, 2003) and as an agent in placemaking (Local Government Association, 2017), acting as a catalyst of social encounters and as a locus of cultural production, consumption, and participation for their staff and visitors (Brook, 2016; Hooper-Greenhill et al., 2009). Perhaps most strikingly, the geographer Hilary Geoghegan has argued in favour of a museum geography, an endeavour that we strongly endorse (Geoghegan, 2010). Yet despite the valuable research so far conducted, there has been no systematic, quantitative, large-scale study of the national geography of museums. Here we provide that study. This research is part of the Mapping Museums project,¹ which has collected the largest, most complete dataset about museums in the UK from 1960 to 2020 to study the sector's temporal and geographical development (Candlin et al., 2020a). This informational asset allows us to chart a novel geography of UK museums, overcoming the limitations of previous efforts.

Sitting at the intersection of quantitative human geography and museum studies, this paper addresses several fundamental research questions about the spatial distribution of museums in the UK, at an unprecedented level of completeness. As a first epistemic cut, we delimit the scope of this paper to *where* museums are located, studying *what kinds* of museums appear in different areas, with museum governance and size as fundamental attributes. We further restrict the analysis to a spatial snapshot of the sector as at December 2017, without considering the temporal dimension that is at the core of other studies (Candlin et al., 2020a). Explaining the factors that underpin the distribution of museums is complex and multifaceted and has been addressed elsewhere (Candlin et al., 2022). With the aim to produce a detailed quantitative geography of UK museums, we focus on the following two research questions:

Q1. What is the distribution of museums in the UK, overall and by region? What is the density of museums with respect to the local population, by nation, region, and Local Authority District?

Q2. What is the distribution of museums in the UK when grouped by their attributes, overall and in relation to the local population at multiple spatial scales? Core attributes include museum size and governance. What categories are over- and under-represented?

The project's resources are available online as open data.²

2 | MUSEUM GEOGRAPHIES

Many disciplines have touched on the spatiality of museums as an object of investigation, usually focusing on single institutions or on small groups of institutions. Museum scholars have written about the architecture of individual buildings or about the experience of walking through or otherwise occupying those spaces (Duncan, 2005; Leahy, 2012; MacLeod, 2013). Proposing the term 'museum geographies', Hilary Geoghegan examined the emotional geography of the Science Museum in London (Geoghegan, 2010, 2013). Other academics have gone beyond the walls of the museum to consider how museums are a component of civic space or function as agents of civic representation and urban regen-

eration (Giebelhausen, 2003). The provenance of museum collections and how objects have been acquired and moved across the globe have become increasingly important subjects of academic scrutiny (Gosden et al., 2007; Tythacott & Arvanitis, 2014). Eileen Hooper-Greenhill et al. (2009) are unusual in using quantitative methods to analyse the spatial flows of school visits to museums in England, using postcodes as anchors in a discussion of audiences and social deprivation.

Museums also feature in discussions of the socio-spatial aspects of cultural consumption and participation. While the field has generally been dominated by the discussion of social class, a regional analysis of cultural participation that considers class, age, and place shows how local differences, neighbourhood effects, and deprivation have an effect, beyond the broader North–South divide (Leguina & Miles, 2017; Miles & Gibson, 2016; Widdop & Cutts, 2012). Studying the residential geography of visitors to music and arts venues in London, Brook et al. (2010) identified higher education qualifications and geographic accessibility as main factors to explain visiting behaviour. A subsequent study of neighbourhood effects on museum visitors in London confirms that education and spatial accessibility contribute to shaping visits to museums (Brook, 2016). However, these studies of London can seldom be generalised to the UK, given the significant gap between the capital and the rest of the country in terms of arts funding (Dorling & Hennig, 2016).

Closely related to museum geographies lies the ‘geography of heritage’ (Graham et al., 2016). Here, museums are considered as one element among many. Core objects of study are heritage *location*, looking at how it is bound to specific places, its *distribution*, as places will exhibit different concentrations of heritage, and its *scale*, as places possess different forms of heritage at different scales, from the local to the global, using qualitative methods. Similarly, museums feature in geographies of tourism and recreation as loci that generate tourist flows (Hall & Page, 2006). From a more economic perspective, the geography of cultural industries observes the spatial agglomeration of sites of cultural production and consumption, including museums (Pratt, 2011). In Pratt’s view, these sites ‘have a distinctive spatial distribution: tending to cluster in parts of cities and to concentrate in a small number of cities in the world’ (p. 323).

Adopting a quantitative approach, the Taking Part Survey investigates participation in culture in England, stating that 9% of respondents felt cultural events were hard to get to, without distinguishing between types of museums and only at a coarse regional level (Department for Digital, Culture, Media & Sport, 2017). With a similar spirit, the RSA’s Heritage Index³ integrates several data sources about British heritage at the local authority level, surveying the number of assets (such as buildings) and activities (e.g., community initiatives) (Schifferes, 2015). This index fostered discussion about the definition and nature of heritage, of which museums are considered a central and traditional asset, and about regional inequalities. While it includes museums, the RSA’s index has a broader scope and our dataset is significantly more detailed and complete.

From a museum studies perspective, we support a critical move from centres to peripheries, away from national museums in London to more diverse institutions and contexts that have long been neglected (Candlin, 2015). The new geography of museums that we chart in this paper provides an overview of the sector in its diversity and scope, exploring the space and place of museums at a larger scale. Having more complete data is not just a statistical desideratum, but has already had a tangible impact on policy, as discussed below. Here, we offer a detailed quantitative study of the location of UK museums, providing a basis for further study on the factors underpinning museum distribution, and the social inequalities of access to museums and participation within this specific cultural sphere.

3 | THE MAPPING MUSEUMS DATABASE

The Mapping Museums project produced a new database that includes all museums open to the public between 1960 and 2020, reaching an unprecedented degree of completeness at the national level (Candlin et al., 2020a). The most significant aspect of this dataset is that, while previous surveys only considered museums accredited through the official UK Museum Accreditation Scheme, we included unaccredited museums. Of 3262 museums active in the UK as at December 2017, almost half were unaccredited (1612). Since the actual number of museums in each region was unknown and is highly relevant for provision and public funding allocation, Arts Council England and the Welsh Government used our new data to update their funding model, with the inclusion of unaccredited museums.

From an ontological perspective, this collection is the result of the harmonisation of existing contemporary data sets of museum sector bodies and historical administrative data, which required a combination of conceptual modelling and ontology engineering (Ballatore & Mooney, 2015; Kitchin & McArdle, 2016). All entries were manually curated by the experts involved in the project and verified using multiple sources, including websites, phone calls, and meetings with sector professionals from museums, local history societies, and tourist boards.⁴ As the data about the museum sector

is notoriously fragmented and of uneven quality, the project cross-checked, harmonised, and integrated a wide range of data sources, such as the Mendoza Review and the Museums Development Network regional surveys (Candlin & Poulouvassilis, 2020). From a geographical perspective, we aimed to collect coherent data at the UK level, in the spirit of the Miles Report (Museums and Galleries Commission 1986). The collection of information about unaccredited museums was particularly challenging, as was the collection of data for the UK as a whole: after devolutions in the 1990s, England, Scotland, Wales, and Northern Ireland bodies conduct country-specific data collections.

The data collection faced ontological and practical challenges, rooted in the definitional problem of what should be classified as a museum over 40 years of intense cultural and societal changes. Rather than adopting an existing British or international definition, the project developed a novel definition through an iterative, incremental process of critical review (Candlin & Larkin, 2020). Museums are hence defined as (i) having a permanent collection, (ii) displaying artefacts from the collection, (iii) being regularly open to the public, and (iv) having a threshold, to distinguish them from displays in public buildings, for example. This definition excludes botanical gardens, zoos, libraries, aquaria, archives, and monuments (unless they contained a stand-alone museum) as well as temporary, mobile, and online museums. Particularly for the 2017 snapshot analysed in this paper, we are extremely confident in the completeness of the dataset, which includes all open museums.

Substantial efforts were required to define a comprehensive and yet clear and precise conceptualisation of museum attributes, and develop a formal ontology (Poulouvassilis et al., 2019). For each museum, 24 attributes were collected, complemented by provenance attributes.⁵ Financial data were outside of the project's remit. The core attributes that are relevant to this analysis are location, governance, size, and subject matter. *Location* refers to the physical geolocation of the museum's main buildings. The source is the museum postcode converted to latitude and longitude pairs through the ONS Postcode Lookup Dataset, and manually verified for accuracy (Poulouvassilis et al., 2019). Museums generally have a single location, although some local authority museum services are umbrella groups that may be associated with multiple museums and locations.⁶ In these cases, each museum was listed separately and, if a museum had moved, we selected the most recent address. Given the scale of our analysis, these postcodes offer sufficient resolution to locate museums and to calculate areal statistics. The other core attributes will be discussed in the next sections, excluding subject matter, which we will analyse in subsequent studies.

4 | SPATIAL DISTRIBUTION OF UK MUSEUMS

4.1 | The location of museums

The Mapping Museums database allows users to investigate a variety of detailed questions about museums in the UK. First, we turn our attention to a central research question that we can answer at a new level of completeness: Where are museums in the UK (Q1)? This question is of particular cogency to policymakers, as the number of museums in each administrative area was simply unknown, especially in relation to unaccredited museums that make up almost half of the sector. Given the lack of spatial assessment directly comparable to ours, we propose this as a robust baseline to observe previous and subsequent distributions of museums. In this analysis, we focus on a snapshot of the museum sector in the UK on 31 December 2017. The analysis includes museums that were open at the end of 2017, thus excluding all museums that closed before that date and that opened in 2018 or later. The data collection relevant to this national snapshot continued well into 2020. The temporal and historical dynamics of the openings and closures of museums that led to this state of affairs are outside the scope of this analysis and are addressed in detail in other studies (e.g., Candlin et al., 2020b).

Visualising the uneven distribution of museums in the UK is essential to studying its geography. After experimenting with different visualisations, hexagonal grids emerged as the best approach to intuitively present this distribution at the national scale. Figure 1 shows the resulting map that aggregates the museum counts at a readable scale, which allows us to identify broad spatial patterns (smaller units result in very sparse aggregations, with more than 90% of empty cells).⁷ Of the 2999 cells that cover the UK, 55% contain no museums, while 43% of cells have between 1 and 10 museums. The densest cells containing 10 museums or more are located, in decreasing order, in London, Edinburgh, Glasgow, Manchester, Liverpool, Portsmouth, York, Oxford, Cambridge, Bristol, Winchester, Hull, and Stoke-on-Trent. Birmingham is the only large city without such a cluster, as its 26 museums are distributed over a larger area. Some of these clusters highlight a strong connection between the location's history and their subject matter, such as Portsmouth with navy-themed museums and Winchester, a relatively small city, with military museums. A notable linear pattern is visible in Northern

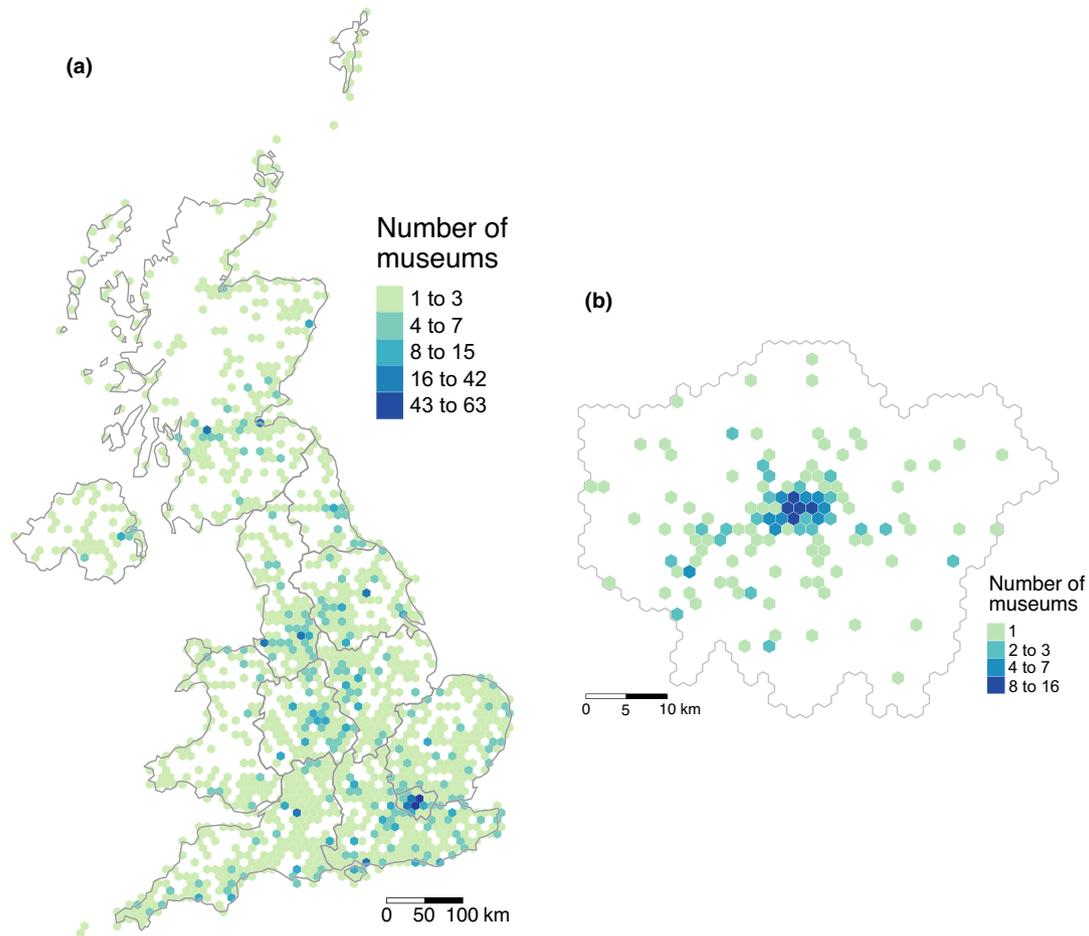


FIGURE 1 (a) Spatial distribution of museums in the UK, as at December 2017, with English region boundaries. Total number of museums: 3225. Each hexagonal cell covers approximately 100 km^2 (38.6 mi^2). The bins were defined using a k-means approach. (b) Distribution of all museums in Greater London, as at December 2017. Number of museums: 226. Each hexagonal cell covers an area of 2 km^2 (0.7 mi^2); 770 cells are empty (87%). The bins were defined using function 2^x .

England along Hadrian's Wall, from Carlisle to Newcastle. It is important to note that these figures refer to the absolute count of all museums, ranging from prominent government institutions to small independent ones (see next sections for an analysis of museum size).

The highest density is found in Central London, where more than 100 museums are located. Given the geographic and cultural prominence of the capital in the UK, we illustrate the distribution of museums in Greater London in Figure 1b, which includes 226 museums. Based on visual inspection, London museums are tightly clustered in the centre, with large peripheries with very few (if any) museums. The densest areas appear in Central London in notable historic neighbourhoods, such as Kensington and Chelsea, Marylebone, Bloomsbury, Covent Garden, City of London, and Westminster. Other relatively dense areas with more than two museums per cell include Chiswick, Kew, Twickenham, Greenwich, Wimbledon, and Hampstead. This coarse geography draws attention to a handful of urban centres as museum hubs. While this is an expected result at a macro-scale, this new dataset allows the elicitation of several more granular findings.

4.2 | Museums and population density

Museums appear to concentrate largely in prominent urban areas. To explore the relationship between museum and population density, we start by observing UK nations and English regions (Q1). Table 1 shows the number of museums per 100,000 residents in UK nations and English regions. While England is too large to be compared with Scotland, Wales,

and Northern Ireland, the three smaller nations can be meaningfully compared to the ONS English regions, having populations in the range between 1.9 and 9.1 million. This regional comparison does not aim at hiding important differences between the four UK nations, but it provides a scale of analysis between the nations and much smaller spatial units. This scale is of particular use to the museum sector, as the museum development programmes across the UK are organised regionally.⁸ Adopting this approach, it is possible to compare 12 units (3 nations and 9 English regions) and to observe that the average value is 5 museums per 100,000 people. The z-scores help to assess the divergence from average, with negative values being below average and positive values above.

In England, museums tend to be more concentrated in the South, reflecting the general North–South divide (Dorling & Hennig, 2016). Combined, the South East and South West account for 36% of English museums, while the North East and North West reach only 10%. Scotland has almost 9 museums per 100,000 people, by far the highest prevalence, as already noted in the Miles Report 36 years ago (Museums and Galleries Commission 1986). Wales and the South West also exhibit substantially above average densities (respectively 6.5 and 7.5, $z > 1$), while the East of England and the South East are slightly above average (5.3, $z = 0.2$). All other units have lower densities, with the East Midlands and Northern Ireland slightly below average. The West Midlands, the North East, and the North West are positioned significantly below average ($z < -0.6$). London is surprisingly below average, with only 2.5 museums per 100,000 people, which shows that the capital has relatively few – but extremely large and prominent – museums. In England, despite the clusters in Liverpool and Manchester, this distribution exhibits a typical North–South divide (Baker & Billinge, 2004), with northern regions having relatively fewer museums than southern ones. Considering both absolute and per capita counts, it can be observed how the North suffers from a dramatic lack of museums compared to the rest of the UK, missing out on the potential for income generation and tourism development in relatively less affluent areas.

To observe the spatial variation within these large regions, we consider the Local Authority Districts (LAD), which partition the UK into 382 population units, with boundaries from April 2019. Ninety-six percent of LADs comprise between 50,000 and 500,000 residents, with a median of 140,000. Some smaller and larger outliers can be found at the tails of the distribution (about 2200 to 1,140,000 residents as minimum and maximum population). The 2018 population estimates were selected, being as close as possible to the 2017 museum data. When placing museums into these units,

TABLE 1 Number of museums in UK nations and English regions in absolute counts, in percentage, by resident population with z-scores, and top local authority districts (LADs), as at December 2017

Spatial unit	Museums (N)	Museums (%)	Population 2017 (million)	Museums per 100,000 people (w/z score)	LAD with highest museum N	LAD with highest museums per 100,000 people
England	2454	75.2	55.62	4.4 (n.a.)	Cornwall	City of London
Northern Ireland	85	2.6	1.87	4.5 (−0.3)	Armagh City, Banbridge and Craigavon	Armagh City, Banbridge and Craigavon
Scotland	484	14.8	5.42	8.9 (2.1)	Highland	Shetland Islands
Wales	202	6.2	3.13	6.5 (0.8)	Powys	Gwynedd
English regions						
East Midlands	223	6.8	4.78	4.7 (−0.2)	Derbyshire Dales	Derbyshire Dales
East of England	329	10.1	6.17	5.3 (0.2)	East Suffolk	North Norfolk
London	223	6.8	8.82	2.5 (−1.4)	Westminster	City of London
North East	92	2.8	2.64	3.5 (−0.8)	Northumberland	Northumberland
North West	241	7.4	7.26	3.3 (−0.9)	Cheshire East	South Lakeland
South East	477	14.6	9.08	5.3 (0.2)	Isle of Wight	Isle of Wight
South West	415	12.7	5.56	7.5 (1.4)	Cornwall	West Devon
West Midlands	230	7.1	5.86	3.9 (−0.6)	Shropshire	Stratford-on-Avon
Yorkshire and the Humber	224	6.9	5.45	4.1 (−0.5)	East Riding of York.	Ryedale

Note: The z-scores exclude England, allowing a comparison across UK nations and English regions, showing the divergence from average (5 museums per 100,000 people). Total number of museums: 3225. The population data are from the ONS population estimates (2018).

LADs are very heterogeneous, ranging from 0 to 77 museums, with median equal to 6 (Q1). The bulk of LADs (93%) host between 0 and 20 museums, with a tail of extremely high values. These LADs are shown in Table 1, distinguishing between the units that have the highest museum counts and the highest density. Only three LADs are without museums (Hart, Blaby, and Selby, all in Yorkshire and the Humber). This distribution makes this scale of analysis appropriate, as smaller administrative units would be mostly empty (e.g., LSOAs or OAs).

Figure 2 shows the number of museums per 100,000 residents, using a topological choropleth map and a cartogram that represents each LAD with a square (Q1).⁹ This variable ranges from 0 to 126, with median of 4. This power-law distribution, shown in the histogram in the figure, is rather typical in human spatial processes, with most units having few museums and few units having many museums (Jiang, 2015). In the group of LADs with the highest values, shown in Table 1, it is possible to identify UK museum hotspots, using z scores to estimate the distance from average. LADs that can be considered outliers ($z > 3$) include City of London (11 museums for about 8700 people, $z = 11.8$), Isles of Scilly (2 museums, 2200 people, $z = 8.2$), Shetland Islands (16 museums, 23,000 people, $z = 6.3$), Orkney Islands (13 museums, 22,000 people, $z = 5.1$), and Outer Hebrides (13 museums, 27,000 people, $z = 4.1$). Other LADs with very high density include North Norfolk, South Lakeland, West Devon, and Stratford-on-Avon. The largest LADs in terms of presence of museums, which can be thought of as museum hubs, are Cornwall (77 museums, 566,000 people), Highland (59 museums, 236,000 people), and Dorset (51 museums, 377,000 people), as well as Armagh City, Banbridge and Craigavon, Powys, Derbyshire Dales, East Suffolk, Northumberland, Cheshire East, and Shropshire (Q1). From a museological angle, these geographical data point to the host of processes that explain the emergence of museum hubs, offering opportunities to delve into specific case studies. Investigating this is more complicated than usually assumed. For example, City of London museums were linked to guild structures; Orkney and Shetland Islands to tourism, specifically to heritage tourism connected to their ancient sites; Cornwall to tourism similarly, but also to tin mining.

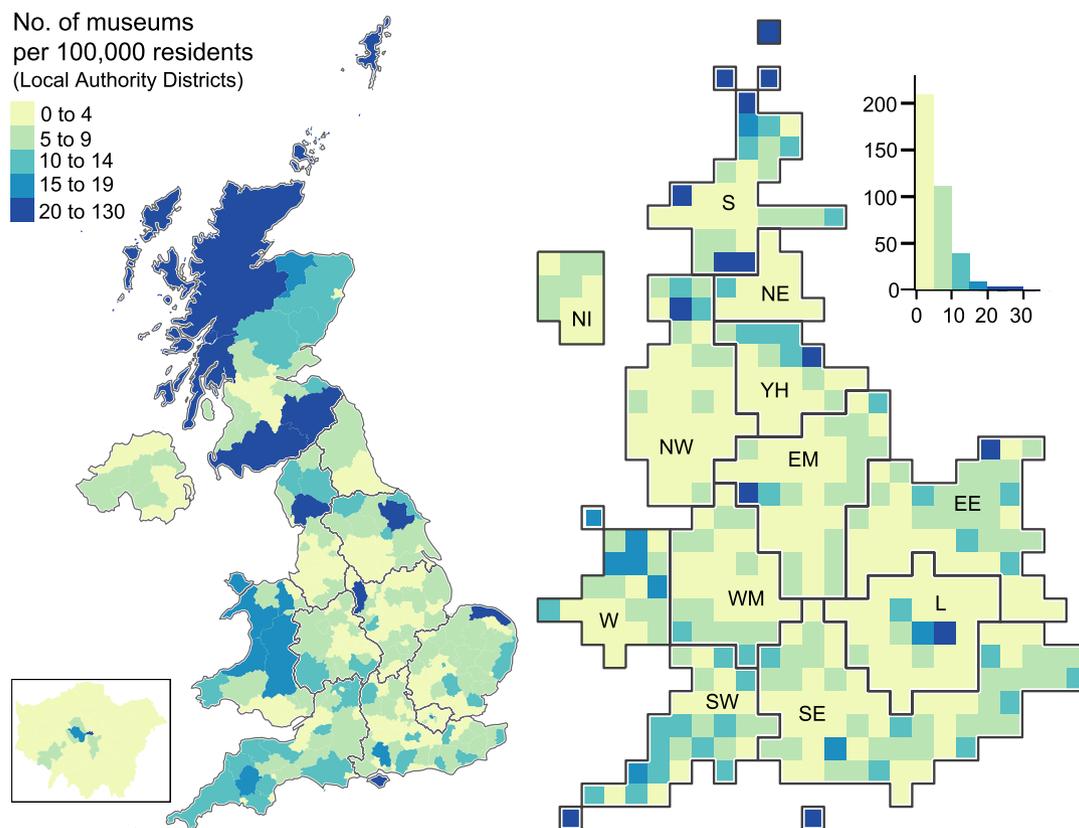


FIGURE 2 Number of museums by 100,000 residents in 382 local authority districts (2019), as at December 2017, with a choropleth and a cartogram, in which each LAD is represented as a square, with the borders of English regions. Abbreviations of nation and region names are shown for readability. The inset represents Greater London. Population estimates from ONS (2018). Total number of museums: 3225. The bins are defined as equal intervals with the 20–130 bin including the right tail of high values. The 2018 population data are from the ONS population estimates (ONS, 2019).

To further study the relationship between population and museums (Q1), Figure 3 allows a complementary comparison between these two variables across LADs, highlighting units where both variables are high (high–high, in dark brown), low (low–low, in light grey), and units hosting relatively few people and many museums, and vice versa. Interesting spatial patterns can be observed. As discussed above, London exhibits an extreme instance of the centre–periphery model, with a large central hub surrounded by museum-free suburbs, indicating a lack of provision for people living in peripheral parts of London and an exceptional offer for Central London dwellers and tourists. The North West is divided into a northern part with high density of museums and a southern part with high population and relatively few museums, similar to Wales, which again suggests a higher provision for tourists than for residents. Scotland exhibits a central urban core surrounded by northern and southern tourist areas with low population and high museum density. Yorkshire and the Humber also exhibits a divide between the more populated South West and the rest. The other regions appear more heterogeneous and fragmented (Q1).

5 | DISTRIBUTION OF MUSEUMS BY SIZE

5.1 | National distribution

Museums are highly heterogeneous and vary in terms of the functions they perform on their territory, how they are governed, and what subjects they focus on. The size of a museum, intended as the number of visitors, is also extremely important to understand the relationship with the locale that hosts it, across the different types of museums. Notably,

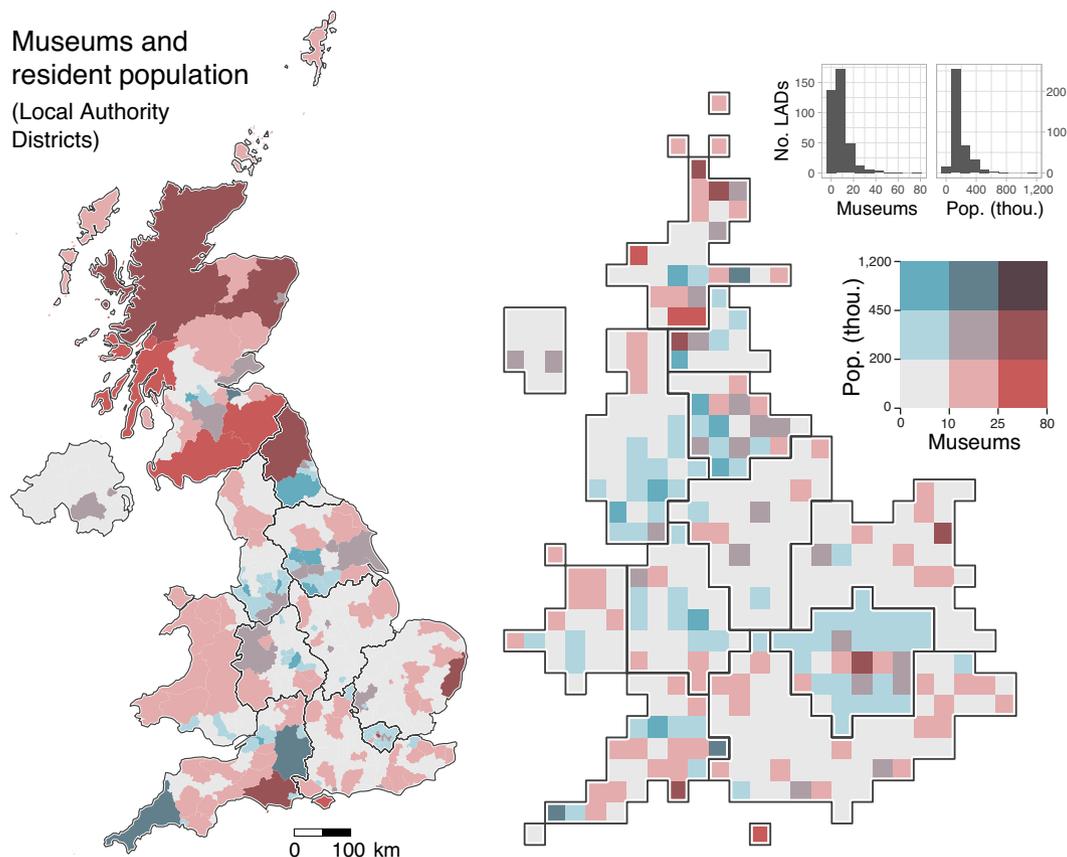


FIGURE 3 Number of museums compared with the number of residents in 382 local authority districts (2019), as at December 2017. The same two variables are displayed with a choropleth and a cartogram, in which each LAD is represented as a square, with the borders of English regions. Dark brown (high–high) indicates areas with relatively high population and many museums, while grey areas (low–low) are areas with a relatively low population and few museums. The same data are used to generate Figure 2. The nine bins are defined with Jenks. Total number of museums: 3225. The population data are from the ONS population estimates (2018).

national museums tend to be large and cater predominantly for global audiences, while small museums are more tightly enmeshed with their immediate surroundings, providing valuable services to local communities. In the analysis of distribution presented so far, the top museums in London that attract millions of visitors per year are given the same weight as small museums. Hence, it is crucial to delve into sub-groups of museums to highlight the spatial structure of the sector. Table 2 summarises the composition of museums by size and governance by UK nation and English region.

The most significant proxy to estimate the museum size is the annual number of visits, assuming that the same visitor can be counted multiple times, i.e., counting unique visits and not unique visitors. Museum size is described using four ordered categories, from small (0–10,000), medium (10,001–50,000), large (50,001–1 million), to huge (1 million or more), which capture the magnitude of visits. These categories (except for huge) are commonly used in the sector, notably by the Association of Independent Museums (Candlin & Poulouvasilis, 2020). The visit information was among the hardest to retrieve, with a high degree of incompleteness. For each museum, the size is based on the latest available record from a wide range of surveys and sources (Candlin et al., 2020b). As no record was available for 45% of museums, we devised a machine learning technique to impute the missing values. Noting that the distribution of museum size is statistically correlated to other attributes (e.g., independent, unaccredited museums tend to be small), we used a random forest classifier to estimate the museum size from known attributes such as accreditation, governance, subject matter, and country. As detailed in Poulouvasilis et al. (2019), this approach reached an overall accuracy of 86%. While the data contained fairly strong signals for small and large museums, medium ones were double-checked manually by the project team. The size remains unknown for 54 museums (1.6% of museums). The distributions of each size category are displayed in the maps in Figure 4.

Most museums in the UK are small (57%) and medium (27%), and far fewer are large (15%) and huge (0.4%). This distribution in museum size across the UK appears to follow an exponential power law (approximately $y = 2^{-x}$), as observed in many phenomena, such as the population of cities, airport size, and building height (Jiang, 2015). In other words, few, large, central objects generate most of the activity, with a long tail of small nodes, as is clearly visible in Figure 4. Notably, the British Museum and Tate Modern by themselves attracted more than 11.6 million visits in 2017,¹⁰ which corresponds to more visits than those received by the about 1800 small museums open in the UK at the time (generously assuming an average of 5000 visits to each small museum). This indicates a remarkable unevenness in the distribution of museum size, as the two most prominent museums in London attract a larger number of visits than all small museums in the UK. Although the number of visitors provides an indicator of activity and prominence, it is important to note that it is only one of the facets to quantify a museum's impact. Small museums with relatively few visitors may still provide crucial cultural spaces and services, contributing to placemaking and celebrating local communities and their industries (Candlin et al., 2022).

In relative terms, England has the lowest proportion of small museums (54%) compared with other UK nations. England has proportionately more large (17%) and medium (28%) museums than the other three nations. The sector in Scotland has the second highest proportion of small museums (66%) and also the highest proportion of huge museums, reflecting the predominance of Edinburgh and Glasgow as cultural capitals. Northern Ireland, by contrast, is dominated by small museums, with the highest proportion across the nations (68%). To interpret these data, it is worth considering that small museums tend to be volunteer-led, as they are predominantly community ventures, unlike other size categories that tend to employ professional staff. In this sense, the presence of small museums might point to a high degree of social engagement.

5.2 | Regional distribution

Observing the prevalence of museums at the regional scale is extremely important, as most of the funding and management of the sector operates at this level. The regional variability of museums by size is explored in Figure 5, which enables a regional comparison both in terms of number of museums and museums per 100,000 people. For example, the South East hosts a number of small museums (262) that is above the regional average but a below-average number per 100,000 people (2.9). Looking at population-scaled values, which are more useful to understand the prevalence of museums, some regions appear under-represented in all size categories (North West, West Midlands, East Midlands), while the South West and Scotland are over-represented, particularly regarding small and medium museums. The other regions are mixed: London has fewer small, medium, and large museums than average, but dominates the huge ones (11). The North East has fewer small and medium museums than average but hosts above-average large museums. Northern Ireland is under-represented for medium and large museums but has a relatively high predominance of small museums. A potential implication to this distribution, given the importance of local history museums in these size categories, is that communities in the North and Midlands may be less able to preserve their local histories and identities.

When considering the percentages in Table 2, the majority of museums in each spatial unit are categorised as small. The region with the highest proportion of small museums is in the East of England (68%), surpassing the national aver-

TABLE 2 Museums in the UK by nation and English Regions, including size and governance categories, as of December 2017

	N museums	Size (visits) %					Governance %					Gov. total (%)	
		UK total (%)	Small	Medium	Large	Huge	Unknown size	Size total (%)	Government	Independent	University		Unknown govern.
UK nations													
England	2454	76.0	41.1	21.3	0.9	0.3	0.5	76.0	17.0	56.1	2.0	1.0	76.0
N. Ireland	85	2.6	1.8	0.6	0.2	-	0.1	2.6	1.0	1.4	-	0.2	2.6
Scotland	484	15.0	9.9	3.1	1.5	0.1	0.5	15.0	4.1	10.1	0.7	0.2	15.0
Wales	202	6.3	3.8	1.7	0.8	-	-	6.3	2.0	3.8	0.2	0.3	6.3
English Regions													
East Midlands	223	6.9	4.1	1.8	0.9	-	0.1	6.9	1.6	5.2	-	0.1	6.9
East of Engl.	329	10.2	7.0	2.3	0.9	-	-	10.2	1.7	7.8	0.4	0.3	10.2
London	223	6.9	3.5	1.6	1.3	0.3	0.2	6.9	1.7	4.9	0.3	-	6.9
North East	92	2.9	1.1	0.8	0.9	-	-	2.9	.9	1.8	0.1	0.1	2.9
North West	241	7.5	3.3	2.6	1.6	-	-	7.5	2.2	4.9	0.3	-	7.5
South East	477	14.8	8.1	4.1	2.5	-	0.1	14.8	2.8	11.3	0.4	0.2	14.8
South West	415	12.9	7.3	3.6	1.8	-	0.2	12.9	1.8	10.8	0.1	0.2	12.9
West Midlands	230	7.1	3.4	2.3	1.4	-	-	7.1	1.9	5.0	0.2	-	7.1
York. and H.	224	6.9	3.2	2.2	1.5	-	-	6.9	2.4	4.3	0.1	0.1	6.9
UK total	3225	100	56.6	26.6	15.3	0.4	1.2	100	24.2	71.4	2.8	1.6	100

Note: All values are percentages of the total number of museums, showing the breakdown between spatial units and museum size and governance. For example, 3.5% of all museums are small and in London; 4.9% of museums are independent and located in the North West; 0.2% of museums are managed by Scottish universities. The total columns are repeated to increase readability. The five largest values in each block are highlighted in bold.

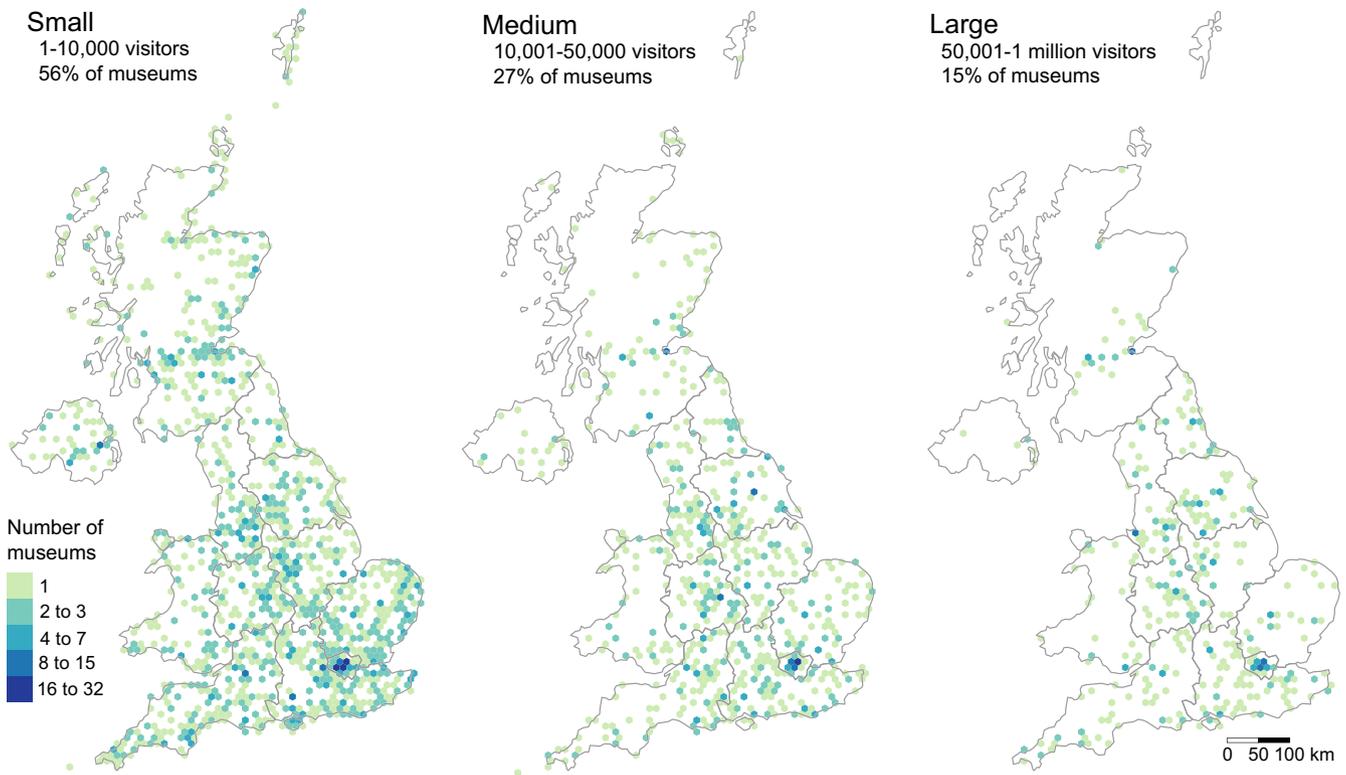


FIGURE 4 Spatial distribution of museums in the UK grouped by size (visitor numbers) with the borders of English regions, as at December 2017. Total number of museums: 3225. Each of the 2999 hexagonal cells covers approximately 100 km² (38.6 mi²). Categories ‘huge’ and ‘unknown’ are omitted (51 museums). The bins were defined manually using a 2ⁿ function.

FIGURE 5 Number of museums in the UK by English regions and nations, grouped by size and governance categories, as at December 2017. English regions and three UK nations are comparable units in terms of population size. The divergence from the regional average is represented with the z-scores, grouped by column. For example, the south east has 82 large museums, which is above average compared with the other regions and nations ($z = 2.1$).



age and also the second highest region (East Midlands, at 59%). Most regions tend to have a distribution of sizes that reflect the power law discussed above, but an exception exists: the North East hosts more large museums than medium and exhibits the most balanced distribution between categories (small: 37%; medium: 29%; large: 33%). This can be explained by the high level of state investment in the North East, to be contrasted with the prevalence of tourist museums in the South West.

6 | DISTRIBUTION OF MUSEUMS BY GOVERNANCE

6.1 | National distribution

As detailed in Candlin et al. (2020b), museum *governance* refers to how a museum is managed and funded and, implicitly, to its purpose. Studying the distribution of museums by types of governance enables a new, nuanced understanding of the sector: knowing where museums governed in different modes provides insights on how public and private actors have invested into museums, shaping provision and resource allocation, and therefore accounting for regional inequalities. Governance can be grouped into three top-level categories (government, independent, and university). For the purposes of the Mapping Museums project, *government* museums include organisations led by local authorities, national museums, and Cadw in Wales.

Typically medium-sized, since the Public Libraries Acts in the late nineteenth century, local authority museums are public services with obligations to local taxpayers, similar to libraries. National Museums, such as the Natural History Museum and Tate, are instead funded directly by central government and manage high-value collections. Their boards are government-appointed and respond to a variety of other stakeholders, including academics, researchers, students, local communities, and tourists, among others.

Independent museums form a broader, more heterogeneous category that includes organisations under English Heritage, Historic Environment Scotland, National Trust, National Trust for Scotland, as well as not-for-profit (charities, community interest companies, unincorporated associations) and private museums owned by individuals or non-charitable organisations. They can either serve special interest groups or immediate local communities. They do not receive government funding and have therefore to respond more directly to market conditions, securing donations and tickets for their running costs. Finally, *university* refers to museums managed by universities.

In the whole UK sector, 24% of museums are supported by government institutions, while 71.5% are independent (see Table 3). Most government museums are managed by local authorities (22%), while independent museums are primarily not-for-profit (46%) and private (14%), with other sub-categories being much smaller. The spatial distribution of museums by governance is shown in Figure 6. Government museums clearly appear clustered in the major conurbations, including London, Birmingham, Manchester, and the capitals of the nations. By contrast, independent museums possess a more diffused geography, indicating that they pursue different functions and audiences. Linear patterns of independent museums are visible along Hadrian's Wall, the Scottish coastline from Inverness to Fraserburgh, the Southern coastline of England, and the coast of Norfolk and Suffolk. Interestingly, in England, the bulk of independent museums are concentrated along a ridge starting from London and continuing on a North–West axis to the Lake District, up to the Scottish border, and on the coastline from East Norfolk to the Southern coast of England.

6.2 | Regional distribution

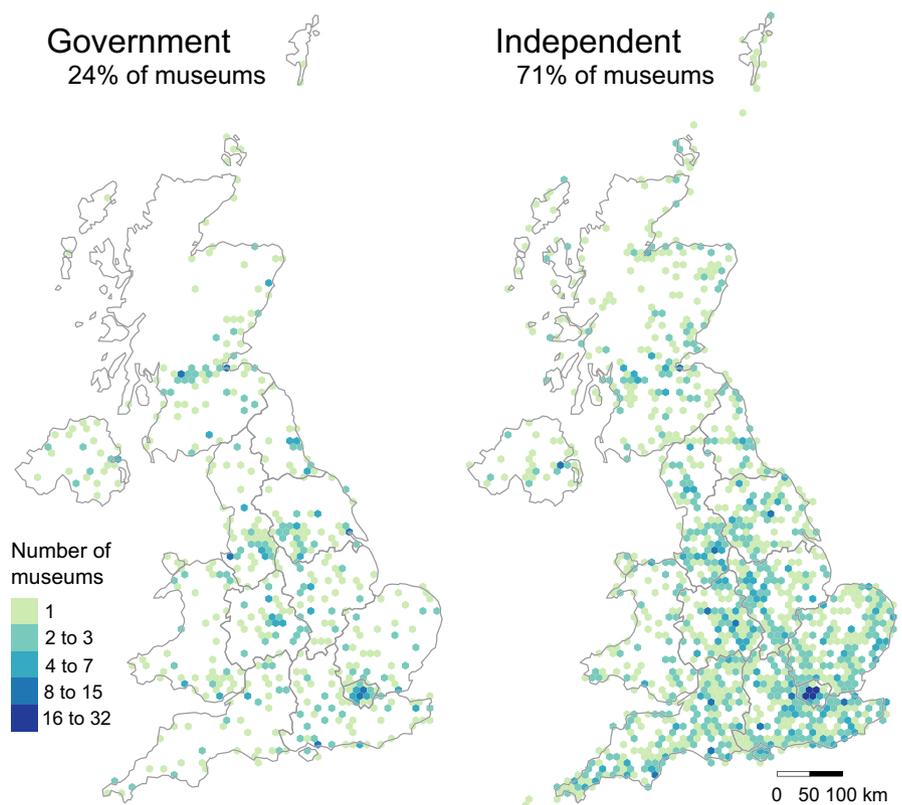
While every spatial unit has more independent museums than government ones, the balance of these categories varies across UK nations and English regions. As can be observed in Table 2, England has the lowest proportion of government museums (23%) and the highest proportion of independent museums (74%), while Northern Ireland has respectively the lowest and highest proportions (40% government and 54% independent). As is possible to observe in Figure 5, Scotland and the South East have the highest number of government museums. When considering the number of government museums per 100,000 residents, all English regions converge to the value of 1, with London being lower (0.6) and Yorkshire and the Humber higher (1.4), indicating a high level of planning in the allocation of these museums, reaching a surprisingly even distribution. This is evidently the case for local authority museums, which are seen as public services like libraries to be made available to each community through non-market provision.

National museums too exhibit some planning, although to a lesser extent. In 1960, there were few national museums outside the capital cities of the four UK nations, with England having just three branches outside London. Our data show that in 2017 there was at least one national museum in every English region apart from the East Midlands, and some regions even hosted several. This dispersion was intentional, in an effort to decentralise national museum provision and make national collections more accessible to the general public. In the late 1970s, the Standing Commission on Museums and Galleries encouraged national museums to establish branches with different catchment areas to their parent institutions in an attempt to increase access (Standing Commission on Museums and Galleries, 1978). Ten years later, the

TABLE 3 Summary statistics of UK museums by governance, including top-level and sub-categories, as at December 2017

Governance category	N museums	%
Government	784	24.0
Cadw	3	0.1
Local authority	712	21.8
National	57	1.8
Other	12	0.4
Independent	2333	71.5
English Heritage	50	1.5
Historic Environment Scotland	18	0.6
National Trust	183	5.6
National Trust for Scotland	25	0.8
Not for profit	1491	45.7
Private	445	13.6
Unknown	121	3.7
University	91	2.8
Unknown	54	1.7
Total	3262	100.0

FIGURE 6 Spatial distribution of museums in the UK grouped by governance with the borders with English regions, as at December 2017. Total number of museums: 3225. Each of the 2999 hexagonal cells covers approximately 100 km² (38.6 mi²). Categories 'university' and 'unknown' are omitted (144 museums). The bins were defined manually using a 2nd function.



Museums and Galleries Commission (which succeeded the Standing Commission) noted the development of a further 11 national museum branches in regional areas and suggested that national museums might also have a role to play in urban regeneration (Museums and Galleries Commission, 1988). Interestingly, the three smaller nations have twice the number of government museums per 100,000 people (between 1.8 and 2.5), suggesting more public-sector support.

An entirely different picture emerges for independent museums (see Figure 5). The population-scaled values indicate that the South West and Scotland are much more over-represented than the other regions (about 6 museums per 100,000 people), followed by the East of England, the South East, and Wales (about 4), and all other regions are under-represented

(between 2.5 and 3). Given the great variety of independent museums, more detailed investigations should be pursued. University museums have an above-average concentration per capita in Scotland (0.4), double the values in Wales, South East, East of England, and North West (0.2), four times more than in all other regions (0.1), reflecting the distribution of historical universities in these territories.

Figure 7 allows a comparison between the relative predominance of government and independent museums per 100,000 people at the LAD level, making more patterns visible. This figure considers quantiles and not absolute numbers, as independent museums are much more numerous than government ones (2302 versus 779, almost three times as many). In this sense, a unit with high-high values is in the top 33% both for government and independent museums per 100,000 people, while a low-low unit is in the bottom 33% for both. Government museums are relatively more prevalent in southern parts of Wales, the North-West, and the West Midlands. The North East and Northern Ireland tend to have more government museums in almost all their LADs, indicating a proportionally high reliance on public investment. Independent museums appear more predominant in the eastern portions of the East of England and the South East. This comparative distribution is instrumental to assess the uneven representation of public and private actors in the provision of museums across different areas and communities.

7 | CONCLUSIONS

This paper is the first step towards a comprehensive quantitative geography of museums in the UK. The geography that we have started to delineate reveals the spatial unevenness and high variability of museums in space. Analysing the sector in the UK in a snapshot taken at the end of 2017 from the Mapping Museums data, we mapped the geolocation of 3225 museums, answering two research questions. *Q1*. High concentrations of museums can be observed in urban hubs including London, Edinburgh, Glasgow, Manchester, Liverpool, Portsmouth, York, Oxford, Cambridge, Bristol, Winchester, Hull, and Stoke-on-Trent. UK nations and English regions display significant unevenness in the distribution of museums. Museums in England tend to be more concentrated in the South, reflecting the North-South divide. The

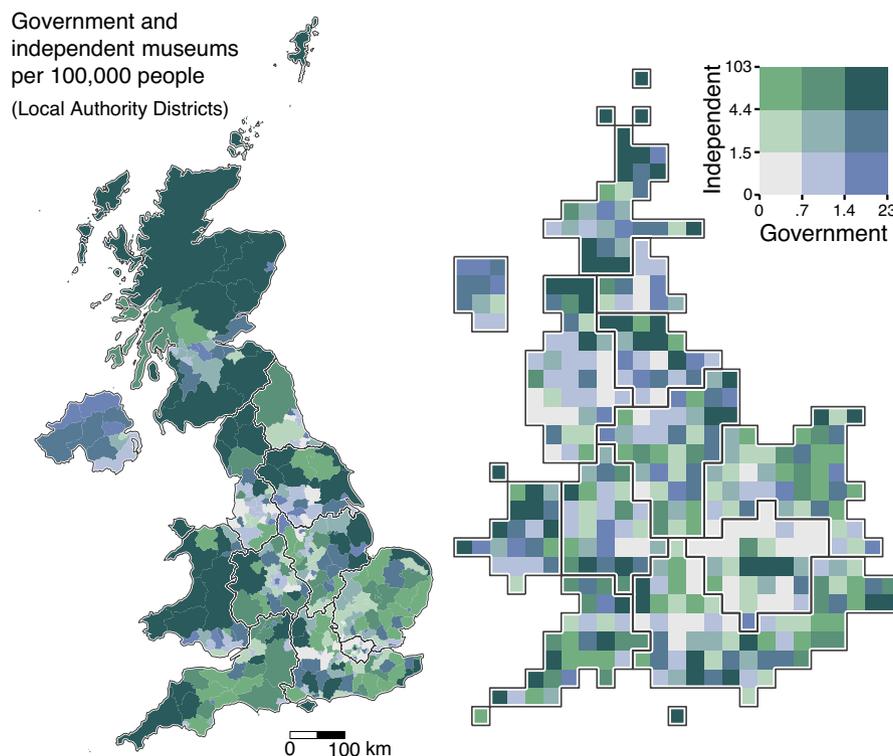


FIGURE 7 Comparison of government and independent museums per 100,000 people in local authority districts, with the borders of English regions, as at December 2017. The same two variables are displayed with a choropleth and a cartogram, in which each LAD is represented as a square, with the borders of English regions. The nine bins are defined with three quantiles for each variable. Total number of museums: 3225. The population data are from the ONS population estimates (2018).

South East and South West account for 35% of museums, while the North East and North West reach only 10%. England and Northern Ireland have a similar number of museums per capita, while Wales and particularly Scotland have higher values. In particular, the Scottish case had attracted attention in the 1980s, when it already had twice the number of museums per capita compared to England (Museums and Galleries Commission 1986). This remarkably stable pattern might be related to its comparatively low population density and high tourist flows. Similarly, when observing museums per capita at the LAD level, outliers with high density emerge, including the City of London, Isles of Scilly, Shetland Islands, Orkney Islands, and Outer Hebrides. Cornwall, Highland, and Dorset are the LADs showing the largest presence of museums. Most of the areas are characterised by a relatively low resident population and high levels of tourism. UK nations and English regions display significant unevenness in the distribution of museums.

Q2. In terms of governance, local authority (about 22%) and not-for-profit museums (46%) dominate the sector. Following a power law, the size of most museums is small (56%), with much fewer being large (15%) or huge (0.4%). A substantial unevenness can be observed in the geographic distribution of museum size. As argued above, this study of the presence of museums by size and governance provides valuable empirical evidence into the sector distribution of provision and resource allocation, both by public and private actors. The variety of museum sizes, modes of governance, and links to local communities and stakeholders shape this museum geography, highlighting its centres, peripheries, presences, and absences. Most evidently, mapping unaccredited museums has already had effects on funding policy, showing the urgency and impact of large-scale, sector-wide quantitative data collection and analysis.

This study provides a stepping stone to many possible directions for new facets of museum geographies, in the UK and beyond. Subject matter is a core attribute whose spatial distribution is likely to uncover patterns in the British museal geography. The spatial clustering and agglomeration of museums can be investigated in detail. Through a modelling approach, 'why' questions can be answered with explanatory factors for the presence and absence of museums, ranging from funding availability and socio-demographic variables to the co-location of other points of interest. More divides that characterise the geography of cultural production and consumption can be explored, for example along the rural–urban spectrum and along ethnic segregation (Brook, 2016). Extending existing efforts (Davis & Lima, 2020), spatial accessibility to museums could be studied at a higher granularity and completeness, acknowledging the role of unaccredited museums. Despite the national focus of this inquiry, the method and questions can easily be transposed to broader international contexts, such as the EU and the US, harnessing diverse and open data sources to chart a global museum geography.

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DATA AVAILABILITY STATEMENT

The code, data, and visualisations used in this article are available at <https://figshare.com/s/527b5dcfdda53d733239>. The full project code base and data are available on the GitHub repository <https://github.com/Birkbeck/mapping-museums>. The datasets produced by the Mapping Museums project are available as open data at <https://museweb.dcs.bbk.ac.uk/data>. All data is free to use under the terms of the Creative Commons (BY) license. This allows users to copy, distribute, remix, and build upon the research, so long the Mapping Museums team is credited with its original creation.

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ENDNOTES

¹ <http://blogs.bbk.ac.uk/mapping-museums> (accessed June 2022).

² See Data Availability Statement.

³ <https://www.thersa.org/projects/heritage/index> (accessed June 2022).

⁴ This study focuses on the UK and not on the Crown dependencies (Isle of Man and Channel Islands), where 37 museums are located.

- ⁵ For attribute definitions, see <http://museweb.dcs.bbk.ac.uk/glossary> (accessed June 2022).
- ⁶ See, for example, <https://www.iow.gov.uk/Council/OtherServices/Museum-Service/Isle-of-Wight-Heritage-Service-Museum-Service> (accessed June 2022).
- ⁷ All maps are projected in OSGB 1936 (EPSG: 27700). Methodologically, all choropleth maps use the best fitting binning strategy, analysing the distribution of the variable to select k-means, Jenks, equal interval, or other methods. For each map, we specify what binning strategy was adopted.
- ⁸ <https://mduk.org.uk/programmes> (accessed June 2022).
- ⁹ Cartogram geometry from <https://github.com/OrdnanceSurvey/equal-area-cartogram> (accessed June 2021).
- ¹⁰ <https://www.alva.org.uk/details.cfm?p=610> (accessed October 2021).

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