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# The Spatial distribution of Hillforts in Britain and Ireland

Simon Maddison

## Introduction

There are over 3300 Hillforts that have been reliably identified in Britain and Ireland. Sites have been recorded in an online database – the Atlas of Hillforts of Britain and Ireland – developed and published as a project out of Oxford and Edinburgh Universities by Gary Lock and Ian Ralston (2017), in collaboration with University College Cork (fig. 1).

This database is notable in being comprehensive, covering not only the British Isles, but also the whole of Ireland. It therefore provided an excellent opportunity for investigating the island wide, pan-regional distribution of hillforts. Whilst there have been previous attempts at such investigations, generally they have been at a regional level, and were undertaken before the advent of modern computers or the development of Geographical Information Systems (GIS) and modern spatial analytical techniques.

This paper summarises the application of such methods to identify regional variation in the distribution of hillforts, as well as clusters or groupings of hillforts that might reflect prehistoric socio-political entities. Percolation Analysis has been used to identify clusters, and this will be briefly described, prior to a presentation of some particularly interesting groupings.

A second approach has been to use the enclosed area of each hillfort to generate geographical distributions in a GIS application, reflecting not only significant variation in site size in different regions, but also possible hierarchies of importance within the previously identified clusters. The working assumption is to use the site's area as a proxy for importance.

A specific regional cluster, the Cotswold Hills in south-central and southwest England, is then investigated in more detail to explore these ideas.

As a next step, the pan-regional pattern of clusters within England is compared with historical counties as recorded in AD1086, showing good correlation in some counties. A further comparison is made with modern genetic studies, also showing good correlation with some regional patterning. These suggest socio-political entities with roots going back to at least the Iron Age, and reflected in much later political administrative

organisations, and social groupings that can be seen in modern genetic studies.

A further extension to percolation analysis identifies sites that are on the edge of clusters but located so as to join clusters together. A specific example is presented suggesting that far from being peripheral it was perhaps importantly located for trade, linking different social groups together.

In conclusion, the analytical approaches presented here can provide a useful starting point for the investigation of regional groupings, or act as a corroborating test for other analyses. They also identify the long term, deep time, importance of geography in the evolution of socio-political entities. There is great scope for further work using these techniques to different geographical regions, and at different geographical scales. As with any systematic analytical method, they can also be readily re-applied with revised data as more information becomes available.

## The Atlas of Hillforts in Britain and Ireland

The Atlas of Hillforts in Britain and Ireland (Lock and Ralston 2017) was the result of a multi-year project run under the auspices of Edinburgh and Oxford Universities, in collaboration with University College Cork in Ireland. The Atlas was published as an on-line database in the summer of 2017, and immediately proved to be a popular and heavily used source (fig. 2). It is invaluable both for the serious researcher, and for the casual explorer who enjoys exploring these iconic sites in the countryside. The database was published online during the Atlas launch conference (Lock, Ralston 2019), where the background and methodology were described in detail (Ralston 2019), and where the use of percolation analysis applied to hillforts was also first presented (Maddison 2019).

This comprehensive, interactive database identifies the location of each site, as well as a very full set of attributes covering the physical features of the site, a summary history of investigations and finds, as well as recording its local environment and condition. It also includes references to primary detailed sources and the relevant Historic Environment Record.

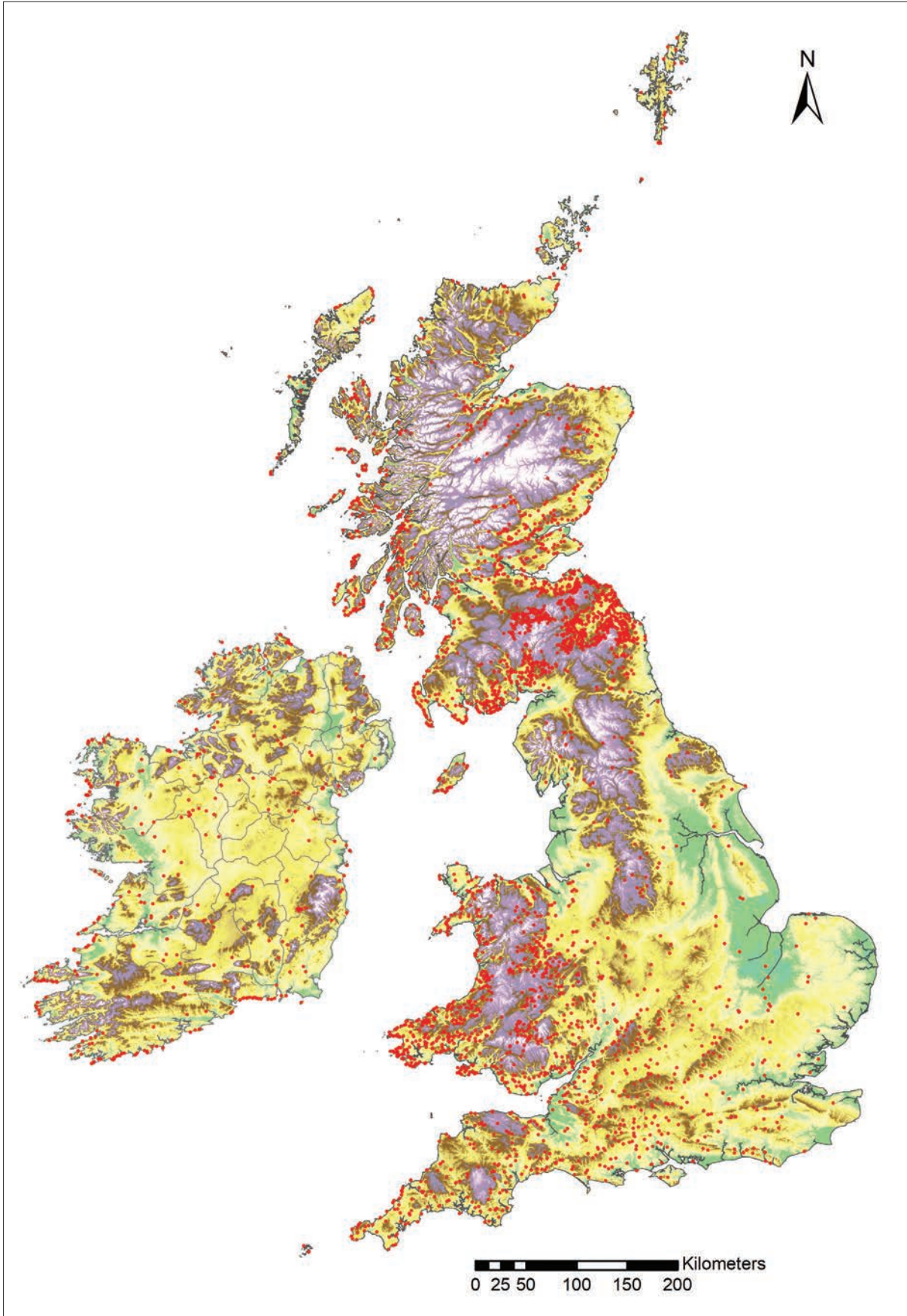
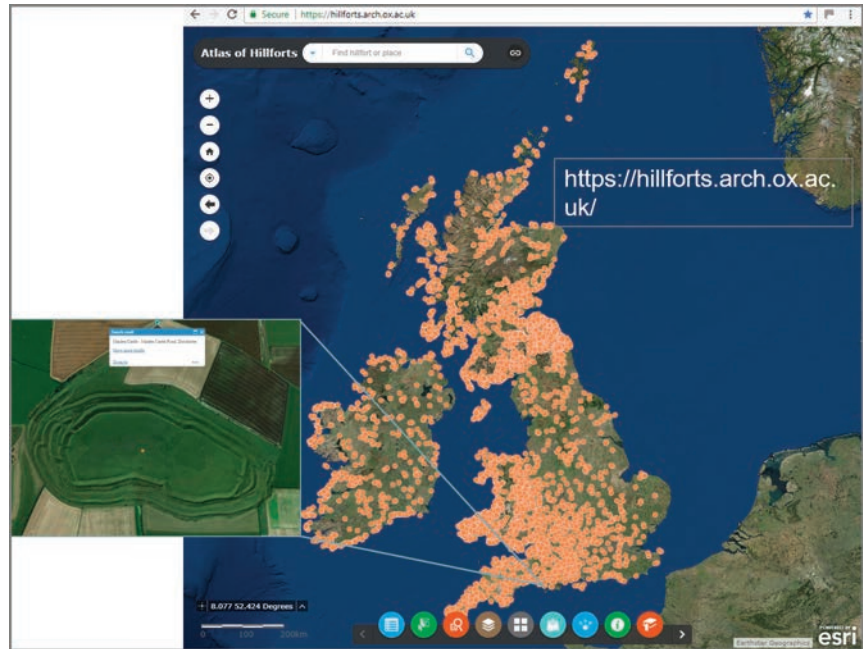


Fig. 1. Hillforts in Britain and Ireland.

Fig. 2. The Atlas website, with one particular site, Maiden Castle, overlaid.



The objective was to include all sites, whether extant, damaged or destroyed. Inevitably there are some sites where there is insufficient data to determine if it can be unambiguously considered as a hillfort. In summary, the selection criteria for the Atlas are: The site's topographical position in the landscape, which should be dominant; the scale of the enclosing works, which should be imposing; the enclosed area should be greater than 0.2 ha.

Two out of three of these are required. Additionally, there are two reliability categories: Reliability of data; Reliability of interpretation. These can be either confirmed, unconfirmed or irreconcilable. Confirmed sites are where at least the reliability of interpretation is confirmed. Sometimes the data is poor, with for example unconfirmed features, but where this site is nonetheless obviously a hillfort (Gary Lock, Paula Levick, pers. comm. 4/4/2016).

For the purposes of the studies described in this paper only Confirmed sites as defined above have been used, and all unconfirmed sites omitted. Broadly speaking Hillforts are attributed to the Iron Age, with some extending back as far as the Neolithic, and some from the early Middle Ages. Note however that although the database contains dating information, this is very incomplete, and only available for between 10-15 % of sites.

The Atlas is a stunningly powerful resource that has considerably broadened and popularised the understanding of hillforts by the public, both in Britain and Ireland, and internationally as well. It has demonstrated the power of modern web-based technology, provides a publicly accessible and definitive source of information for detailed research, and acts as an example of what could be done not only in other geographical regions, but for other types of prehistoric sites as well.

## Spatial distribution of Hillforts in Britain

There is an established history for studying the spatial distribution of hillforts in Britain, one of the first probably being Lily Chitty in Cyril Fox's oft cited 'Personality of Britain' (1932) which provides maps based on qualitative analysis, covering a very wide range of evidence and environmental factors. Nash-Williams (1933), writing shortly after, included an appendix on the distribution of hillforts and other earthworks in Wales (p. 311-315) including a beautifully detailed map, incorporating 822 sites. These were tabulated by county and type (e.g. promontory, hillfort, hut-circle) and also by elevation; their relationship to Roman sites was noted, and a tentative attempt to assign them to tribal territories made, with much discussion about the routes of migration that resulted in their construction. Others have approached the subject since, with Newcomb (1970) being one of the first to use a rigorous analytical technique, Nearest Neighbour Analysis, which he manually applied to the hillforts of Penwith in West Cornwall. Even so, early work on the spatial distribution of hillforts and other types of sites was implemented through painstakingly drawn maps of great beauty, but out of necessity was inevitably qualitative and intuitive in interpretation.

Collis (1981) looked theoretically at hillfort distribution patterns and relationships within the wider context of other types of settlement, and developed models of how relative importance and roles change over time. Although illustrative, this was however not applied to real examples.

From the late 1960s computational techniques started to be applied, most notably by Hogg (1972), who developed a very broad ranging analysis of hillforts in Wales and the Marches based on their size and vallation, and manually established

groupings using circles around specific sites, as well as different settlement forms. His statistical rank test based on size is not easy to understand, but something similar is presented as a log-log rank size plot in Hodder and Orton (1976, p. 72) (credited to Pierson-Jones (1973)), with a computation of the best fit power law. Hogg's work was probably ahead of its time, and as with other work of this period the impact of Carbon-14 dating had not been substantively taken into account.

Hogg (1975, p. 37-45) worked further on maps with symbols based on hillfort size, arguing that size was their most important single attribute. He used these to identify seven or eight distinct regions in Britain, with some tentative explanations of hillfort function, whilst emphasizing the consideration of both size and function in local context. He also noted that whilst hillforts are a characteristic of Iron Age culture in Britain, they are not an essential one and this is supported by the comparative analysis of hillforts and Iron Age finds in England by Maddison (2019).

Gent and Dean (1986) analysed the size of hillforts and plotted them with respect to the productivity of radially determined catchment areas in Wessex, and obtained some quite good correlations, generally also tying in with other hillfort characteristics.

In contrast to earlier work, which was predominantly regional, Cunliffe (1991) looked at hillforts within the context of Iron Age communities in Britain as a whole. He also included much work on distribution patterns of pottery types and other artefacts. He focused most on hillforts in the area where there was the most excavation evidence available, that is to say central southern England. He also discussed regional zones e.g. (1991, p. 527) and how they evolved through the period; along with pottery distributions these are interesting for future comparisons and further study.

What comes out of nearly all later studies is the importance of drawing on detailed data, and the wider context and understanding of the sites analysed, in order to complement quantitative analysis. Computation itself is no magic answer to providing a comprehensive picture of the past. However, it is also clear that compared with subjective studies, the strength of analytical approaches is that they are generally repeatable, and accessible for review, revision and further development, particularly as new and updated data become available.

With the advent of the Atlas it is now possible to undertake an analytical approach to the distribution of hillforts using modern Spatial Analysis and GIS tools. Looking at the plot of sites on a topographic overlay (fig. 1), it is immediately apparent that their distribution is highly non-uniform, with a significant concentration of sites in south and south-east Scotland, and south-west Wales, which has long been recognised. There is a more even spread through south and south-west England, with a very low density north and east of a line roughly between the Thames Estuary and the Dee as far as Northumberland and the Scottish Borders.

It is also very clear that hillforts are almost completely absent from the lowlands along the eastern side of England; there are also very few around the Pennine chain. Although they are located in hilly country, there is generally an approximate limit

in terms of altitude, and they are completely absent from the uplands of the Pennine chain as well as the Scottish Highlands.

This paper attempts to study these nationwide distribution patterns to elicit possible social and political groupings in the time of hillfort construction and use, during the Iron Age.

## Cluster Analysis

Given the Atlas database, and the great regional variety that it shows, it was decided to try and determine 'natural' groupings or clusters of hillforts, based on their spatial proximity, as a first step in seeking regional identity. It was thought that this would be a better approach to this dataset of prehistoric sites, rather than starting with for example modern regions or counties, which might reflect later societal structure and developments. For the reasons outlined below, Percolation Analysis was the technique used for this purpose.

Percolation Analysis was originally developed as an analytical technique within Materials Science in the 1940's (e.g. Stauffer, Aharony 1991). More recently it has been applied in Geography, for example by Rozenfeld *et al.* (2008) and Arcaute *et al.* (2015). Arcaute *et al.* (2014) then applied it in order to study the distribution of Villis as recorded in the Domesday Book. This document was compiled on the orders of William the Conqueror and is a unique record of settlement, population and economy undertaken in the year AD 1086, see for example: *The Domesday Book Online*. Their study was based simply on the spatial distribution of the Vill sites or estates, which were the smallest administrative units of land in England at the time. It was decided to use the same technique of Percolation Analysis for the identification of clusters of hillforts, on a similar basis, and both Elsa Arcaute and Stuart Brookes of UCL provided advice, data and source code in support (Arcaute *et al.* 2014). The analytical code has since been significantly developed, and is now openly available as a package from the Open Science Framework (Maddison and Schmidt 2020), including the Hillfort spatial data as a test dataset.

## Percolation Analysis

An illustration of Percolation Analysis is shown in Figure 3. It operates on the Euclidian distance between points. A radius value is selected, shown as letter *l* in panel i, and one point is selected randomly, shown in red. All points falling within this radius are then part of the cluster, shown in blue. This process is repeated iteratively on all points that are included in the cluster at each step until the cluster grows no further, as shown in panels ii, iii and iv. The process is then applied to all remaining points in turn. Points are either included within a cluster or not. There are limiting values for the percolation radius: there will be a lower limit, at which no points are included in a cluster; and an upper limit, at which all points fall within a single cluster. This is discussed further below.

The process can then be re-applied for different radius values. Examining characteristics of the clusters show how they change over the range of radius values, and this can be used to highlight

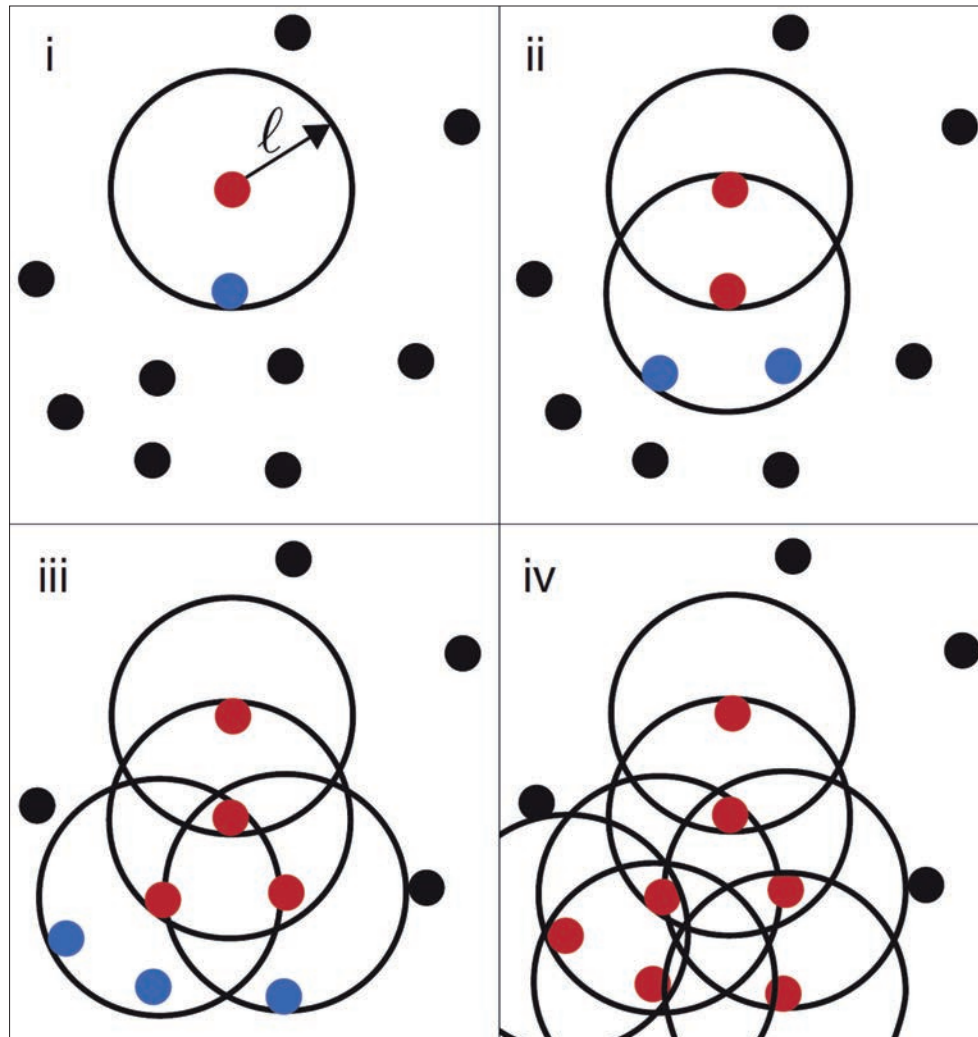


Fig. 3. A representation of how Percolation Analysis works (Rozenfeld *et al.* 2011, Fig. 2 p. 2208; with permission).

ranges which are likely to be of interest (fig. 4), discussed further below.

This technique has the advantage of being simple and intellectually accessible; it does not rely on any assumptions or pre-determination of clusters, other than the percolation radius value. Programs to run the analyses on the hillfort data set were written in R statistical programming language, and a suite of programs developed to print maps and provide additional analysis. The original work is described in detail in Maddison (2016). A fuller description of the technique and its application in archaeology can be found in Maddison (2020).

### Hillfort Clusters

The percolation analysis tools were applied to the spatial data-set of hillforts extracted from the online hillforts database (Lock, Ralston 2017). This paper focuses on the results for Britain. Similar analyses have been done for the island of Ireland but are not included here.

Figure 4 shows a summary of this analysis. The graph plots the maximum size of all clusters, versus the percolation radius in km. A selection of cluster maps are overlaid to illustrate how the clusters change with differing radii. Note that only the largest 15 clusters are coloured for clarity, with red being the largest and blue the next. Other clusters and non-clustered points are shown in grey.

For a radius of zero, bottom left, there are no clusters and all sites are plotted in grey. By 35 km all but a few sites in the outer islands are included within a cluster. The most interesting maps are those that lie in the radius range between 8 and 14 km, and some of these are discussed below in more detail.

Figure 5 shows a plot of hillfort clusters for a percolation radius of 9 km. In the southern part of Britain this shows north-west Wales (mauve), the Clwydian Range (turquoise), south-west Wales (blue), the Gower (pastel orange), central Wales and the Marches (orange) and two clusters on the north-west and the south-east of the Severn Valley (pale brown and green), the latter being the Cotswolds, which are discussed in more detail below. The largest cluster is in South East Scotland, which has a very high density of sites.

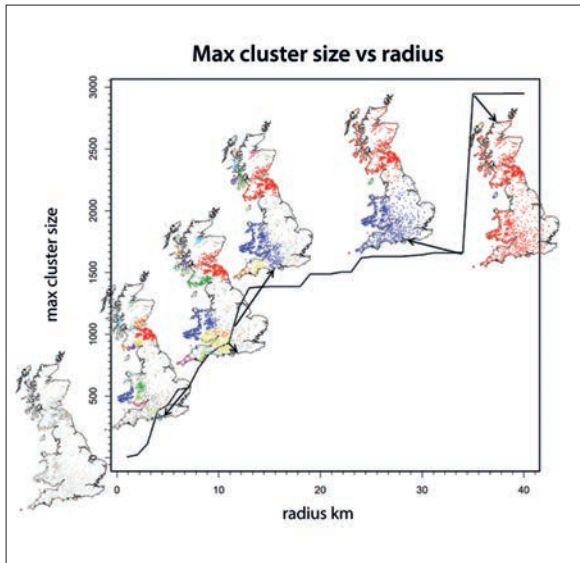


Fig. 4. Graph showing Hillfort Clusters in Britain at radius values up to 40 km.

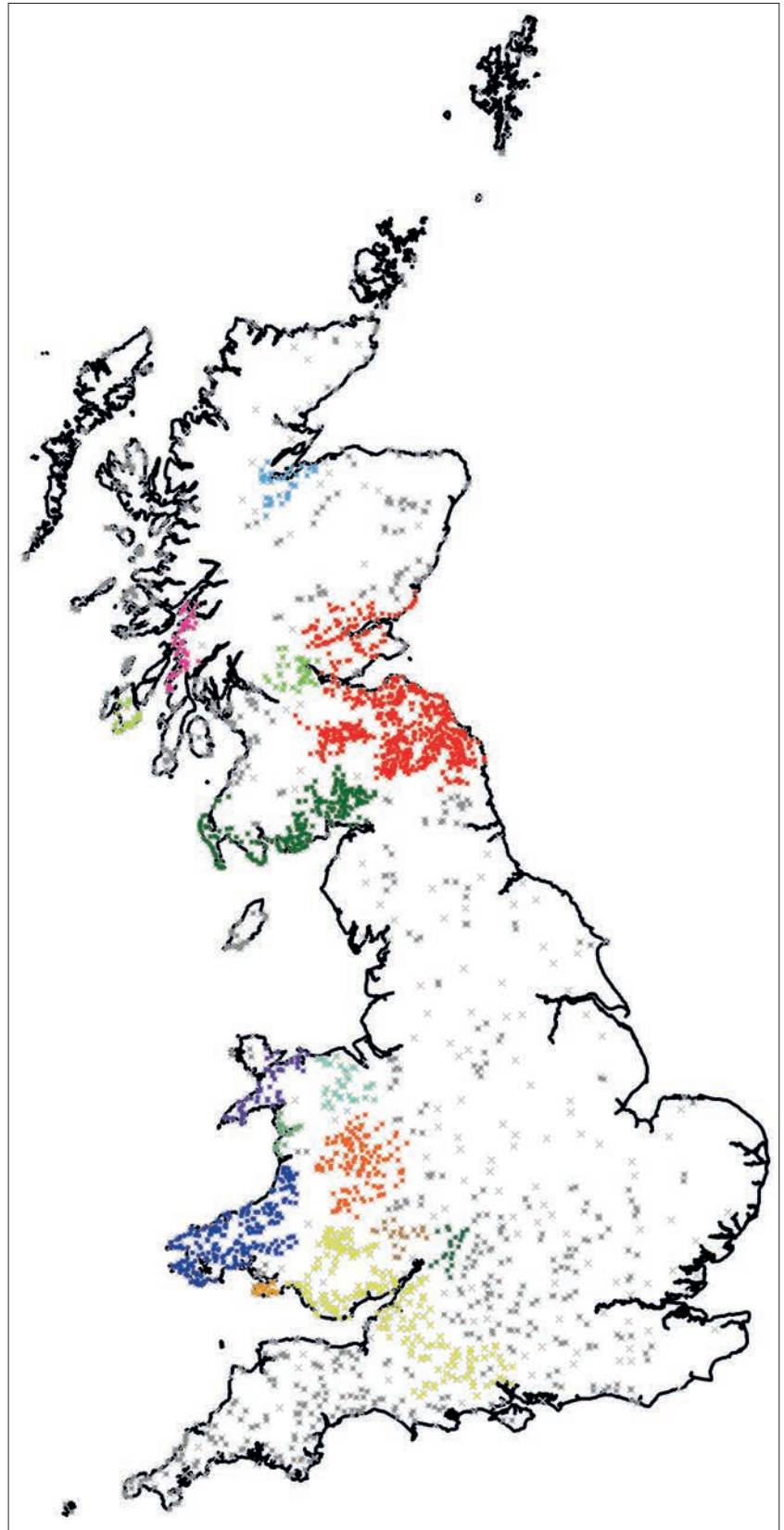


Fig. 5. Hillfort Clusters at 9 km percolation radius value.

The cluster plot for 12 km (fig. 6) shows the two largest clusters encompassing respectively: southern and south-eastern Scotland, and central south-western England and all of Wales. However, Cornwall (orange) and Devon/part of Somerset (yellow) appear clearly as individual clusters, as well as a cluster along the Chilterns (turquoise) north of the Thames. As will be seen below, these clusters closely match distinct modern administrative and geographical/topographical regions.

A selection of these regions have been analysed in more detail, as described in Maddison (2016), and form the basis for ongoing collaborative research. The objective is to establish if these clusters do represent prehistoric socio-political entities, based on other evidence, including that drawn from the Atlas, and to what extent they may be influenced by the regional topography, geology, landscape and agricultural environment. The identification of these clusters is a starting point for this work.

## Comparison with other datasets

### Historical counties in England – ‘Domesday’

For England there is a remarkable historical record of settlement in the year AD1086 captured in the Domesday Book. Of immediate interest are the historic counties, which reflect in large part administrative and political entities established in earlier medieval times and taken over by the invading Normans. Do these echo patterns of the Iron Age? The county structure of England survives to this day and was largely unchanged until the second half of the 20th Century. Plotting hillfort clusters from the Percolation Analyses might give some indication of this.

Overlaying hillfort clusters on these county boundaries, as illustrated for southern England in Figure 7, shows good correlation for a number of counties, namely Devon, Herefordshire and the north-eastern half of Gloucestershire at 10 km radius, and Cornwall, Buckinghamshire and Bedfordshire at 12 km radius.

It is important to note that percolation analysis does not seek to explain, but it does highlight

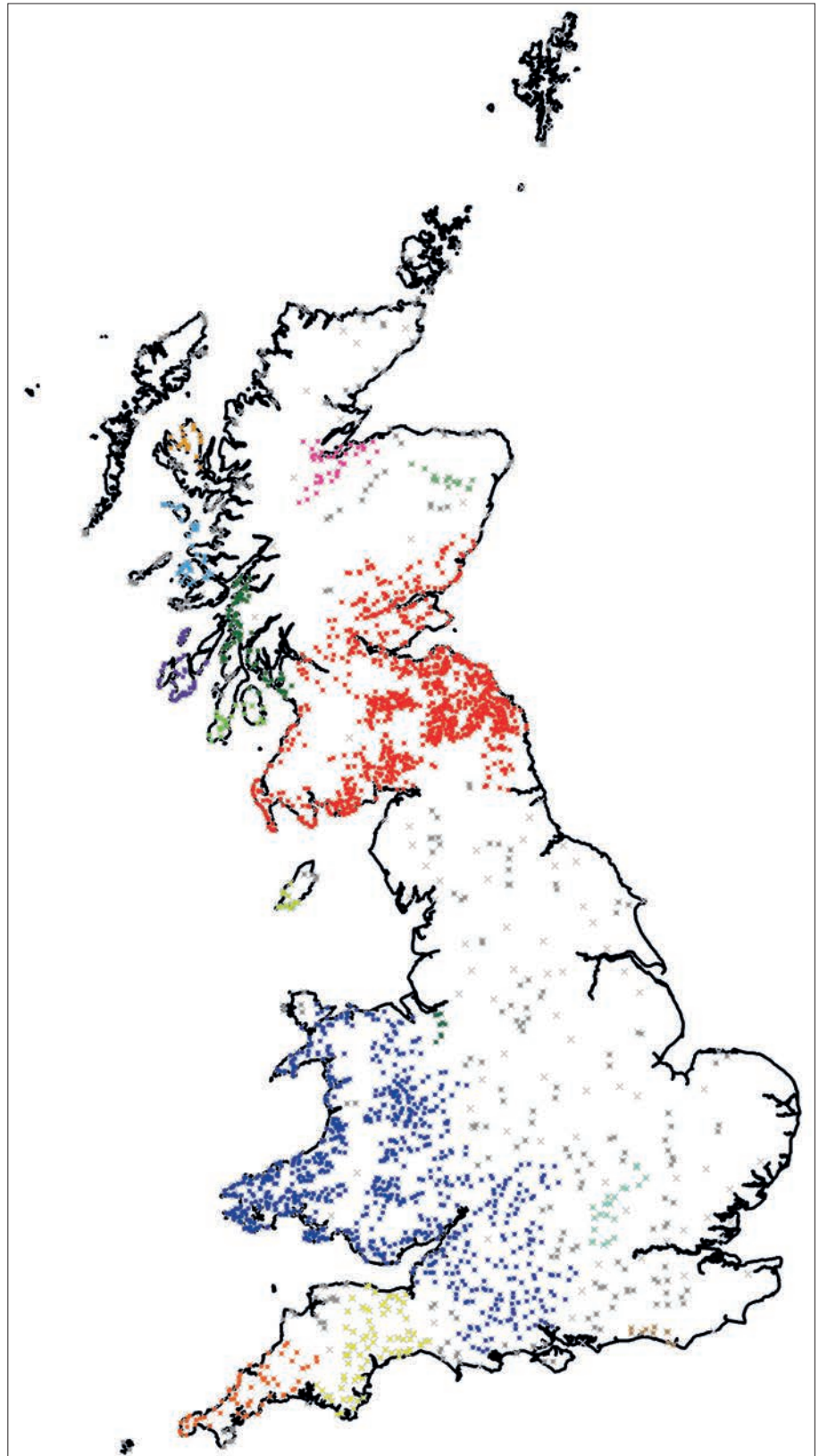


Fig. 6. Hillfort Clusters at 12 km percolation radius value.



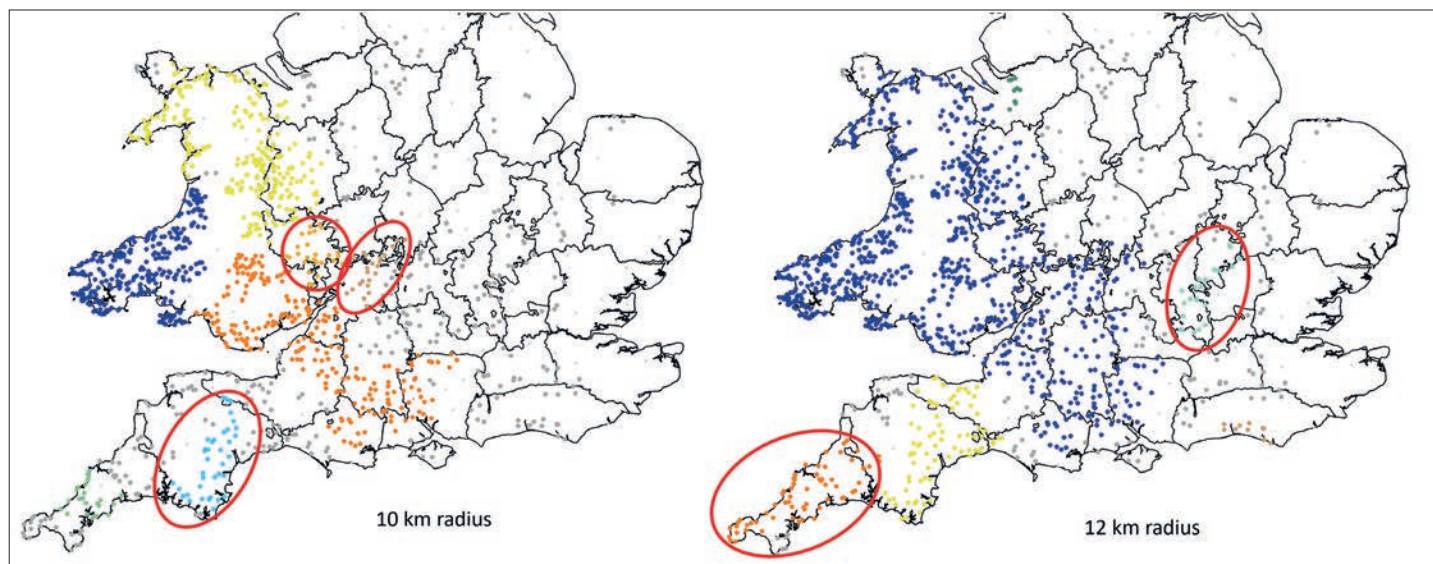


Fig. 7. Hillfort clusters at 10 and 12 km percolation radius values, overlaid on Domesday counties in southern England. Domesday county data provided by Stuart Brookes;

patterns. In this case it suggests that some of the geographical factors that influenced the building of hillforts in south-west England and the Home Counties may have also influenced the formation of administrative and political units by Domesday. It also seems very likely that there was a degree of unitary continuity in these territories which directly evolved through the Iron Age to medieval England, being culturally and community based around a common identity.

The Domesday county boundary data was kindly provided by Stuart Brookes of the Institute of Archaeology at UCL (pers. comm. 2015).

### Modern genetic patterns in Britain

Recent years have shown major advances in the study of Genetics as applied to archaeology, both based on ancient bodies, and modern populations. One of particular interest is that of Leslie, Winney et al. (2015) which reports a fine grained study of the modern population of Britain in order to determine regional variants. The study took for their sample people whose all four grandparents were born within 80 km of their current abode, and therefore reflects a genetic picture of the late 19th Century.

Some of these results are shown in Figure 8. Of particular interest are the genetic distinctions between the population of Cornwall and Devon, as well as those of Herefordshire, south-west Wales and north Wales. These all correlate with clusters of hillforts, some of which can be seen in Figure 5, Figure 6 and Figure 7. As for the Domesday County comparison above, this suggests that the factors that influenced hillfort construction in the Iron Age are also reflected in the population of some parts of modern Britain, and possible continuity of regional society to modern times.

### Hillfort enclosed area

As previously noted, Hogg (1975, p. 37-45) considered the size of a hillfort – as determined by its enclosed area – as the single most important attribute of a hillfort. It is certainly the most readily and robustly determined parameter and is likely the least vulnerable to later site damage.

Hillfort enclosed area is also arguably a very good indicator of site importance; the size of a site will reflect the amount of effort involved in its construction, and therefore the size of the labour force committed to construct it, and the degree of cooperation or coercion that could be applied to the population at the time, and hence political leadership and influence. It will also reflect other considerations, such as the number of people who might occupy the site, either on a permanent or temporary basis, and perhaps also the amount of livestock that might be enclosed, for whatever purpose. This also reflects on political and social importance.

There is a well-established tradition of plotting hillforts with a symbology based on their size. Before Hogg, noted above, probably the most iconic and influential is the map of Southern Britain in the Iron Age (Ordnance Survey 1962). The symbology used was established by Rivet who described the choices made for classifying sites in this work (1958). Entrances were excluded because of the complexity and frequent difficulty of their identification (without excavation); even vallation had its complexities depending on the specific topography and methods of construction. Size however was less ambiguously ascertained and was split into three categories at thresholds of 3 and 15 acres (1.2 and 6 ha), figures for which he does not claim any ‘particular magic’ but were arrived at after some experimentation. These values were subsequently adopted by other authors.

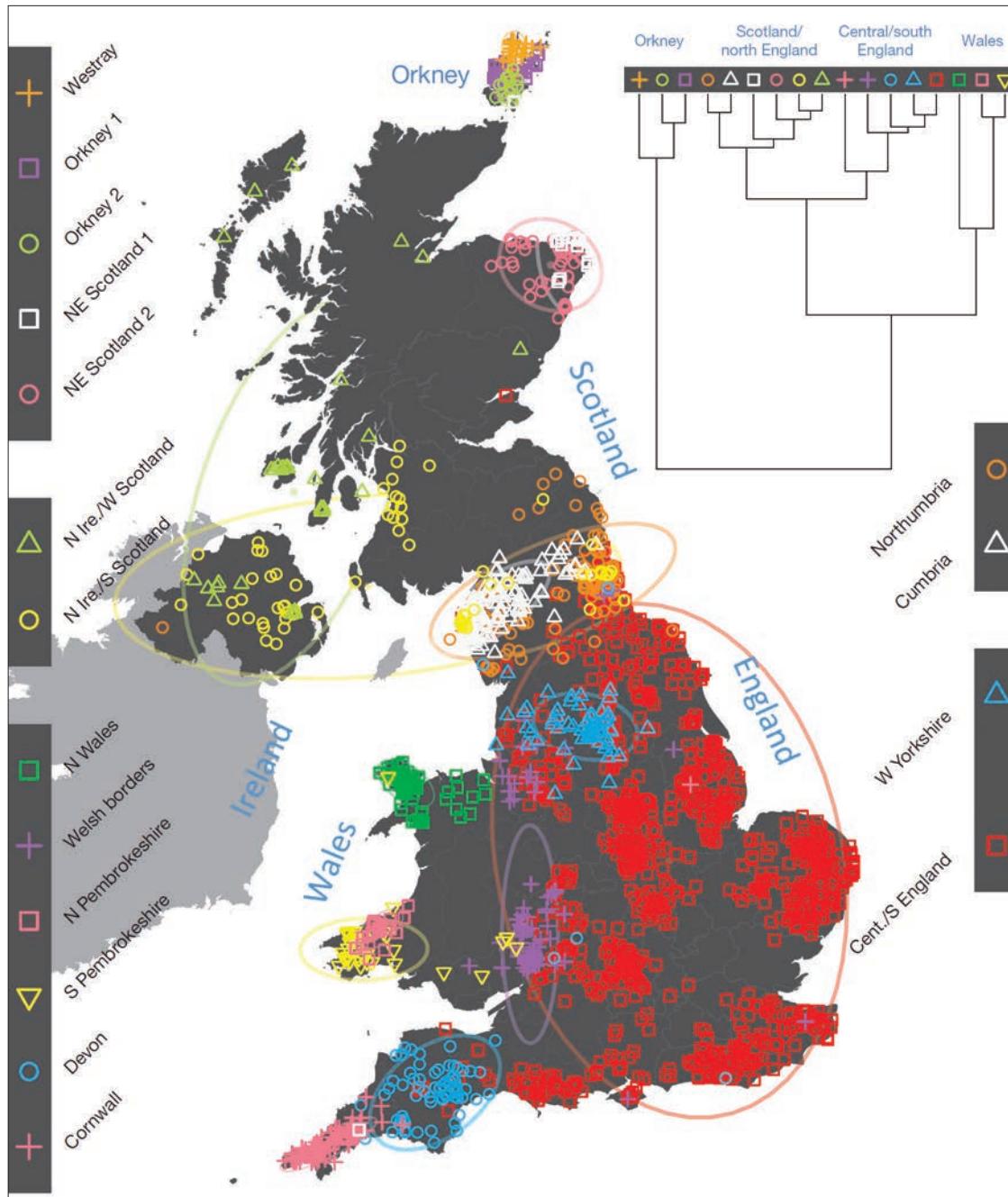


Fig. 8. Genetic patterns in the population of modern Britain (reprinted by permission from: Nature; Leslie *et al.* 2015, Fig. 1 p. 310).

Figure 9 shows hillforts in the British Isles by enclosed area, with symbols for three ranges of size, with thresholds at areas of 4 and 16 ha. These values were established experimentally, using the GIS software ArcGIS, and looking for natural breaks in hillfort size based on histograms. Modern tools such as these readily allow for experimentation, with significantly less work than for pioneers such as Chitty (Fox 1932) and Rivet (1958) in pre-computing times.

It is worth considering for a moment what these values mean in terms of size and scale of a site. Assuming the sites are circular, then the length of just one rampart and ditch for a small site of 0.2 ha and sites at the two threshold values are as follows: 0.2 ha - 159 metres; 4 ha - 709 metres; 16 ha - 1418 metres.

The largest site in Britain is Ham Hill at 84 ha with three ramparts and a perimeter of 3.3 km and in Ireland the largest enclosure is at Spinans Hill of 131 ha with two ramparts and a perimeter of 4 km. Even for a single rampart the larger sites represent massive works of construction.

Looking at the map with site symbols based on area (fig. 9) Ireland has a particularly striking pattern, with its largest hillfort at 131 ha at Spinans Hill. Most notably with the arrangement of the larger sites relatively uniformly distributed around the country. This is potentially suggestive of a regional role played by these sites, in a pattern common across much of the island.

Scotland has a large number of sites, but only one which is just in excess of 16 ha, and only 8 bigger than 4 ha, spread

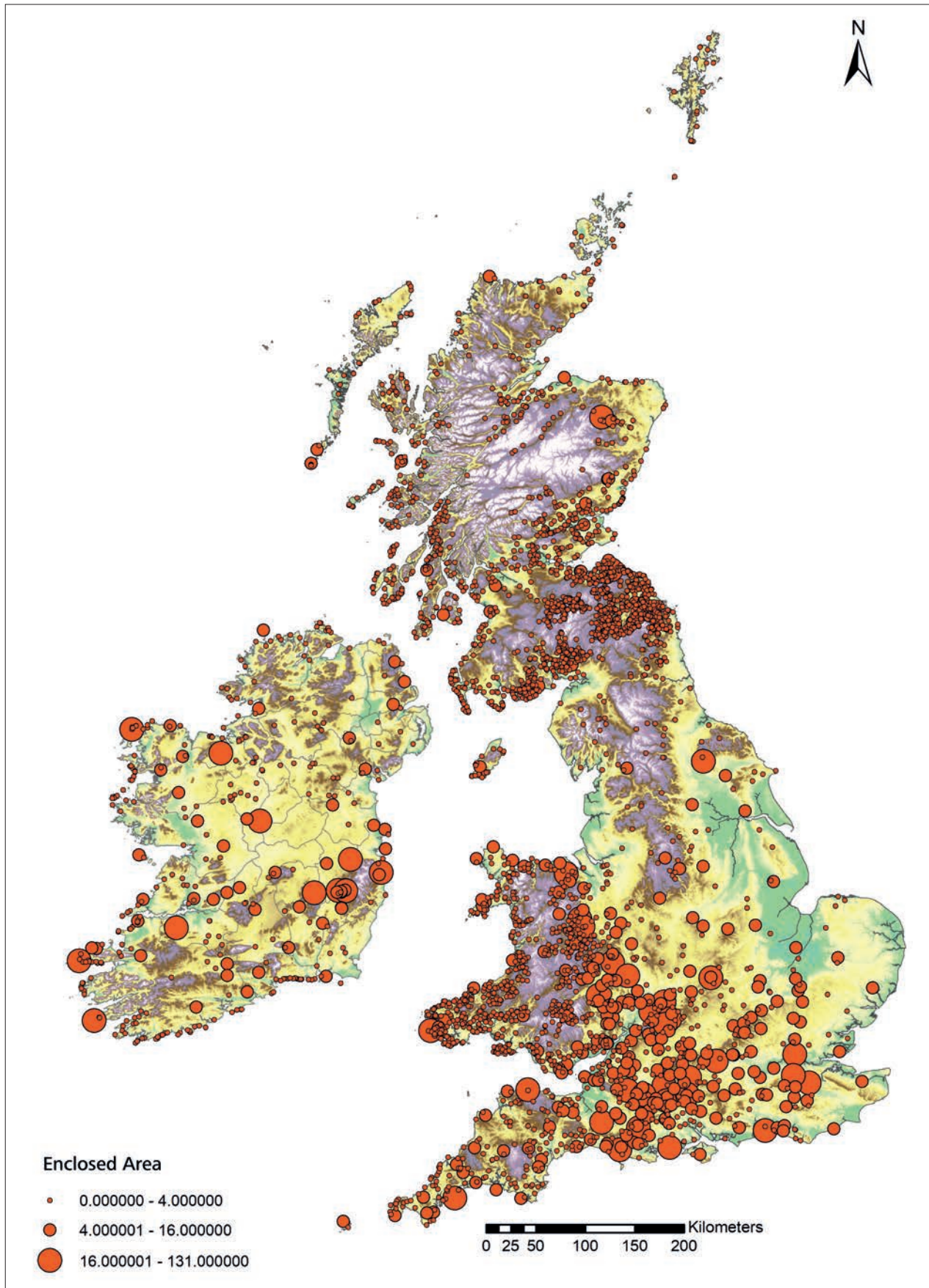


Fig. 9. Hillforts plotted by enclosed area.

mainly along the south-west and west coast and islands. Wales is similar in having a large number of small sites, with a few larger sites in the north-east, and a very small number of large sites, one at the tip of Pembrokeshire at Wooltack Point, and the other Pen-y-cloddiau in the Clwydian range. There are also two large sites on the borders, Llanymynech Hill and Y Breiddin on either side of the Severn as it leaves the hills of central Wales and enters the Shropshire plains.

Although England has a smaller number of sites in total it has proportionally many more mid and large sites than the other regions. These are predominantly along the ridges and escarpments of the hills in south central England. The south-west has a preponderance of coastal promontory forts, and only two large sites: Dodman Castle in south Cornwall, and Countisbury Castle in north Devon.

Apart from the far north-east it is striking how few hillforts there are in northern England, with only a few along the Pennines, and a notable gap to the south of these hills, largely along the line of the Trent and continuing up to the Mersey. In the far north-east, there is no discernible break in density from south-east Scotland over the modern border, with a taper as it

runs down to the line of the Tyne and a break along the course of Hadrian's Wall.

### A specific cluster: the Cotswolds

Figure 10 shows the Cotswold Cluster, already identified in Figure 7, plotted on a topographic DTM, along with modern county boundaries, and with symbols based on hillfort enclosed area.

This cluster, at 10 km percolation radius, is located quite distinctly in the topography of the Cotswolds, with two large and ten other sites on the north-west edge of the steep escarpment overlooking the Severn Valley, and the modern urban sites of Gloucester and Cheltenham. The largest two are Nottingham Hill Camp, which also encloses a Bronze Age barrow cemetery; to the north-east is Willersey Camp, with a Neolithic long barrow in its interior. The presence of these much older monuments within their boundaries suggest the enduring cultural importance of these sites, and this may be reflected in their relative size.

The upper reaches of the Thames are also shown to the south, with one hillfort, Trewsbury next to its source, as well as

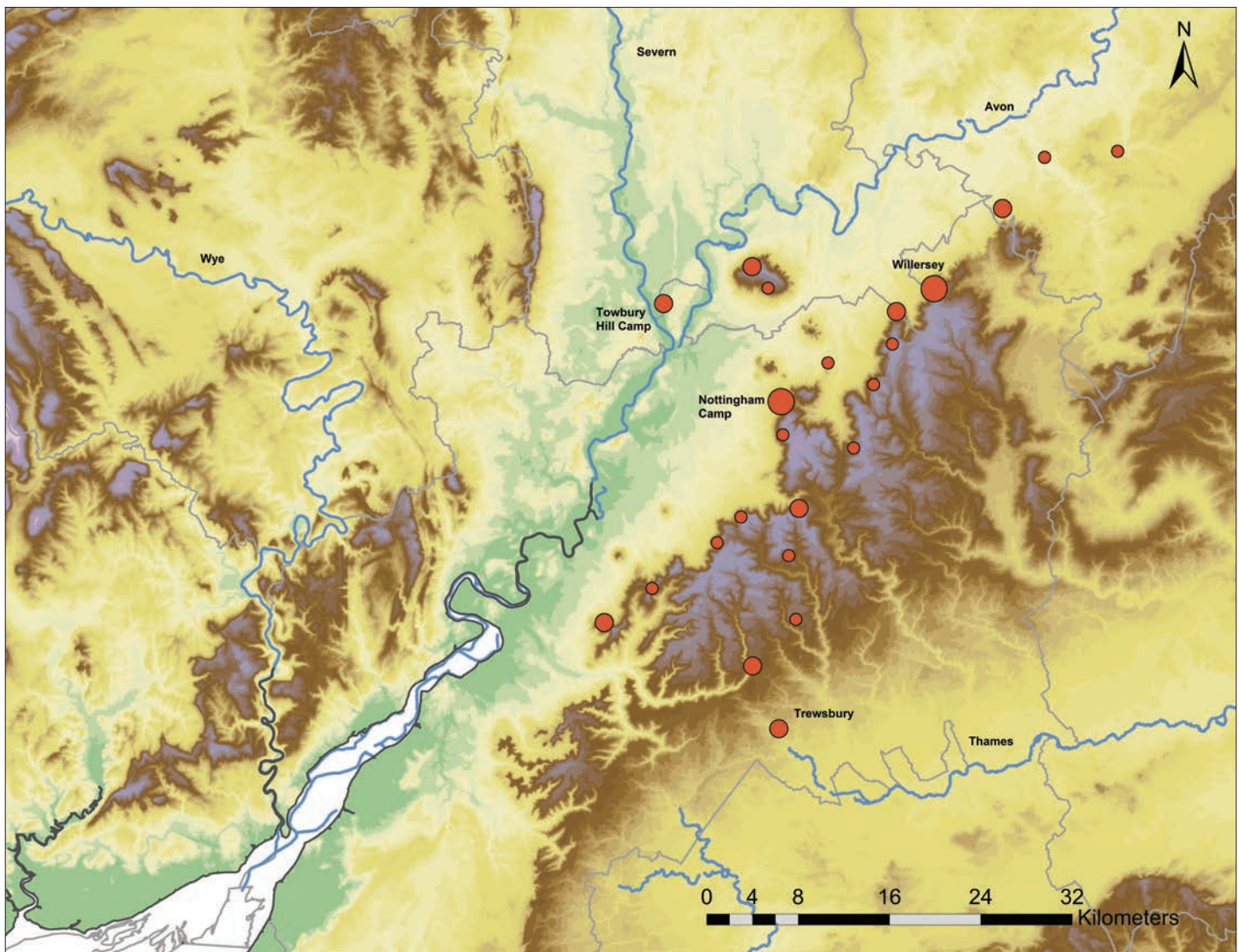


Fig. 10. The Cotswold Hillfort Cluster at 10 km radius.

the Roman Fosse Way, a railway and the Thames and Severn Canal.

Three other sites are very close to the Severn to the north. A particularly interesting one is Towbury Hill Camp, 4 km north of Tewkesbury and very close to the junction of the Rivers Severn and Avon. This site will be discussed further in the next section.

The location of the larger sites reflects not only the longevity of their importance, through incorporation of much older monuments, but also their role in trade, being positioned on key waterways and routes, which have continued in importance right up to modern times.

### Site Connectivity

Mark Lake of UCL has developed a measure of connectivity for sites that act as links between clusters, as the percolation radius increases (Lake *et al.* 2018). This has been incorporated into a GRASS GIS module, originally developed and described in detail by Lake and Brown (2015) for doing percolation analysis using GRASS, and now published (Lake *et al.* 2021). The connectivity coefficient of a site is proportional to the sizes of the clusters that it links, and to the relative size of the clusters. Joining a small cluster to a big one is not significant, whereas joining two large clusters is.

Figure 11 shows the highest connectivity sites for clusters at 10 and 11 km percolation radius. The area straddling the lower reaches of the River Severn, including the Cotswolds, are outlined, for a more detailed discussion below.

Figure 12 shows this area in more detail, at the 10 km percolation radius. The three largest clusters in this area are shown in colour (other sites are in grey). The sites of highest connectivity for each cluster are ringed in red. These are the sites that have joined smaller clusters together at a lower radius. Additionally, the two sites with highest connectivity, that bring all these clusters together at 11 km are shown with a larger red dot. Potentially these sites could be important, acting as key trading centres between the other two clusters.

Figure 13 shows the same plot but overlaid on a topographical map of the region. This also shows the principal rivers, and modern county boundaries. As with Figure 10, the topography brings comprehension to the clusters. What is particularly striking is the situation of the hillforts on the escarpment overlooking the Severn Valley, and their dominant position overlooking the river valley and plain below.

Considering the two hillforts with highest connectivity, when we overlay modern county boundaries, we see that these two sites actually sit in different modern counties (which are very little changed from Domesday county boundaries). The eastern most of the two, Towbury Hill Camp, is particularly interesting; it is located on the peninsula close to the union of the Severn and the Avon, both substantial rivers of importance through history. It is also notable that it is included in Gloucestershire, even though it sits on the peninsula between two rivers.

Viewing this hillfort on satellite imagery in Figure 14 makes its relationship to the rivers clear. It is also interesting to see that

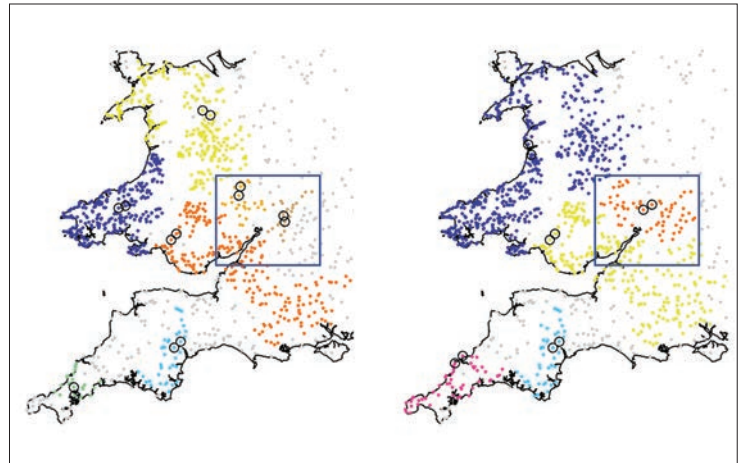


Fig. 11. Sites of High Connectivity at 10 & 11 km radius, Cotswolds boxed.

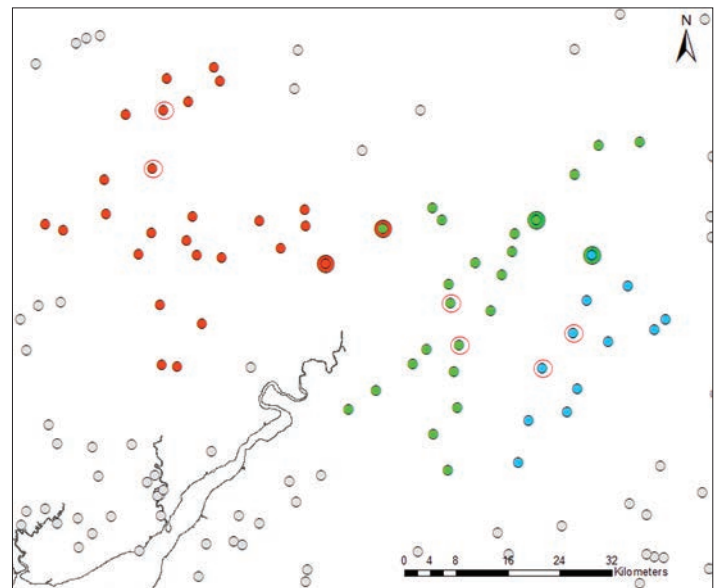


Fig. 12. Hillfort clusters in the lower Severn Valley, showing high connectivity sites at 10 km radius.

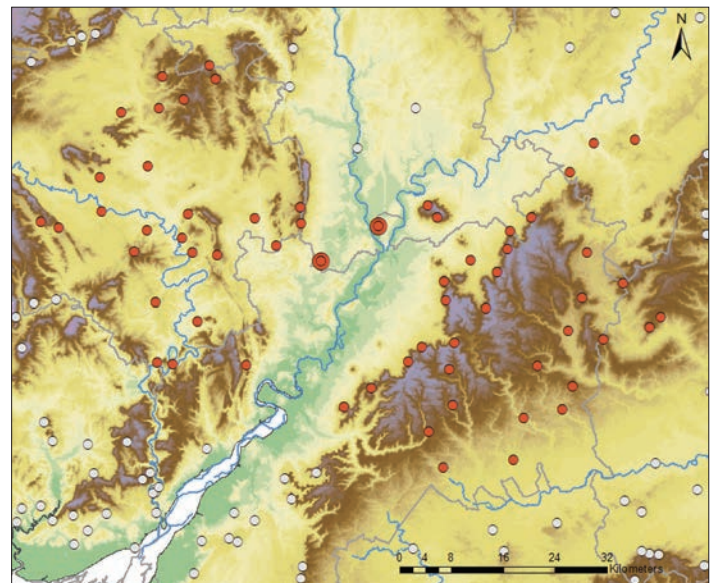


Fig. 13. Hillfort clusters in the lower Severn Valley, topographical plot at 11 km radius, with county boundaries, and highlighting the two sites with highest connectivity.



Fig. 14. Towbury Hill Camp, from the Atlas. The M5 motorway to the right, M50 to the north, and the rivers Severn to the west and Avon to the east. Taken from the Atlas of Hillforts (2017).

it is located extremely close to the M50 Motorway, which links the M5 into Wales and Herefordshire. The M50 was one of the earliest motorways to be built in Britain, attesting to its strategic importance. This location appears therefore to be of importance both in modern and much earlier times.

Towbury Hill Camp has not been investigated, and there is very little known about it, including dating. The evidence from the analysis of the clusters, and its connectivity, additional to the other observations of its position relative to the rivers and county boundaries, would suggest it is worthy of more detailed investigation.

## Conclusions

The publication of the Atlas of Hillforts in Britain and Ireland (Lock and Ralston 2017) is a landmark for archaeology and in the study of the Iron Age. Firstly, it provides a comprehensive and authoritative database of hillforts in these islands. Secondly, by being online and openly accessible it provides a powerful tool both for the serious researcher and the casual enthusiast alike. The publicity that has surrounded its launch has demonstrated not only the popular interest in hillforts but has also acted as a catalyst for wider appreciation and understanding of these monuments. This in turn should be a powerful aid in their conservation and study in the longer term.

Importantly for the researcher it provides a spatial dataset which is readily utilised using modern GIS and spatial analysis tools. There have been maps and gazetteers available in the past, most notably the iconic and inspirational Ordnance Survey Map of Southern Britain in the Iron Age (1962), and the very comprehensive catalogue compiled by Hogg (1979), which was in many ways a precursor to the Atlas. Although there has been a revolution in computerisation, geographic information systems, and spatial analysis tools since then, the necessary effort in extracting

data from such sources is extremely time consuming and laborious. The creation of the Atlas database therefore considerably facilitates the study of hillforts. It also creates a model for other types of archaeological monuments and fields of study, both in the Atlas' home domains and internationally.

This paper has taken an early step in analysing the spatial distribution of hillforts, and importantly taken a 'global' purview as a starting point as opposed to regional study, as in many previous examples. The Atlas database has facilitated and inspired this approach.

Using GIS, analysing the spatial dataset of hillforts and the attribute of hillfort enclosed area, reveals wide regional variation in the nature and size of hillforts both in Britain and Ireland. It has also pointed the way to better understanding the regional role of the larger hillforts, and possible hierarchies of importance.

The application of a relatively novel technique, namely percolation analysis, has generated interesting patterns of clusters that are suggestive of territories and socio-political entities that may have existed in the past. These correspond well with regional geography and certain later historical administrative boundaries, which in turn suggests that the factors that influenced the formation of such entities in the past have continued to be important through time, and the enduring nature of regional society through not only historic but prehistoric times to the present. Indeed, as one example of alternate evidence in support of this, there is some regional correlation with the fine-grained genetic structure of the modern population of Britain. The exploration of 'deep time' patterns from differently and widely varied sources of evidence offers great promise as a further area of research.

In an extension to cluster analysis, Mark Lake has developed a measure of site connectivity to identify those sites that may have been important in linking different territories or groups. The case study in this paper shows this has promise for focusing on specific sites for future research.

The techniques described in this paper are no magic solution to understanding societies in the Iron Age, however they do offer great promise for complementing other approaches and studies, and to help focus future research. For Britain, certain regions identified through cluster analysis have already been selected for more detailed study, and this is ongoing research for the future.

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Tools: R version 4.0.0; ArcGIS 10.7.1; Excel 2016; GRASS GIS 7.4.0

Hillforts Atlas Project: <https://hillforts.arch.ox.ac.uk/>

## References

- Arcaute E., Ferguson P., Brookes S., Reynolds A., 2014. Natural regional divisions of places in Domesday Book. *The Connected Past*. Imperial College London, unpublished.
- Arcaute E., Hatna E., Ferguson P., Youn H., Johansson A., Batty M., 2015. Constructing cities, deconstructing scaling laws. *Journal of the Royal Society Interface*, 12 (102), Article 20140745. (2015).
- Brown T., 2015. *The potential for percolation analysis within archaeology: Constructing and implementing an accessible percolation method*, Unpublished MSc dissertation, University College London.
- Collis J., 1981. A theoretical study of Hillforts In Guilbert G. dir. *Hillfort studies: Essays for AHA Hogg*. 66-76.
- Cunliffe B., 1991. *Iron Age Communities in Britain*, London and New York, Routledge.
- The Domesday Book Online*, [online] <http://www.domesdaybook.co.uk> [Accessed: 7th april 2021].
- Fox C.S., 1932. *The Personality of Britain: its influence on inhabitant and invader in prehistoric and early historic times*, Cardiff, National Museum of Wales.
- Gent H., Dean C., 1986. Catchment Analysis and Settlement Hierarchy: a Case Study from Pre-Roman Britain. In Grant E. dir. *Central Places, Archaeology and History*. University of Sheffield, Department of Archaeology and Prehistory, 27-36.
- Hillforts: Britain, Ireland and the Nearer Continent: Papers from the Atlas of Hillforts of Britain and Ireland Conference, June 2017*. University of Edinburgh, Archaeopress Archaeology.
- Hodder I., Orton C., 1976. *Spatial Analysis in Archaeology*, Cambridge University Press.
- Hogg A.H.A., 1972. The Size-Distribution of Hill-forts in Wales and the Marches. In Lynch F., Burgess C. dir. *Prehistoric Man in Wales and the West. Essays in honour of Lily F. Chitty*. Bath, Adams and Dart, 293-306.
- Hogg A.H.A., 1975. *Hill-Forts of Britain*, London, Hart-Davis, MacGibbon.
- Hogg A.H.A., 1979. *British Hill-Forts, An Index*, Oxford, British Archaeology Reports.
- Lake M., Brown T., GRASS Development Team, 2021. Addon v.percolate. Geographic resources analysis support system (GRASS) software, version 7.8. [online] <https://grass.osgeo.org/grass7/manuals/addons/v.percolate.html> [Accessed: 7th 7th april 2021].
- Lake M., Brown T., Maddison S., 2018. Percolation robustness and the deep history of regionality. *Connected Past*. Oxford.
- Leslie S., Winney B., Hellenthal G., Davison D., Boumertit A., Day T., Hutnik K., Royrvik E.C., Cunliffe B., Wellcome Trust Case Control Consortium, International Multiple Sclerosis Genetics Consortium, Lawson D.J., Falush D., Freeman C., Pirinen M., Myers S., Robinson M., Donnelly P., Bodmer W., 2015. The fine-scale genetic structure of the British population. *Nature*, 519, 309-314.
- Lock G., Ralston I. *Atlas of Hillforts of Britain and Ireland*, [online] <https://hillforts.arch.ox.ac.uk/> [Accessed: 7th april 2021].
- Lock G., Ralston I. dir. 2019. *Hillforts : Britain, Ireland and the nearer continent : papers from the Atlas of Hillforts of Britain and Ireland Conference, University of Edinburgh, June 2017* Archaeopress Archaeology.
- Maddison S., 2016. *The Spatial Distribution of Iron Age Hillforts in the British Isles*, Unpublished MSc dissertation, University College London.
- Maddison S., 2019. Using Atlas data: the distribution of Hillforts in Britain and Ireland. In Lock G., Ralston I. dir. *Hillforts: Britain, Ireland and the Nearer Continent: Papers from the Atlas of Hillforts of Britain and Ireland Conference, June 2017*. Oxford, Archaeopress Archaeology,
- Maddison S., 2020. Percolation Analysis. In Gillings M., Haciguzeller P., Lock G.R. dir. *Archaeological Spatial Analysis: A Methodological Guide*. London and New York, Routledge,

- Nash-Williams V.E., 1933. An early Iron Age hill-fort at Llanmelin, near Caerwent, Monmouthshire : with a note on the distribution of hill-forts and other earthworks in Wales and the Marches. *Archaeologia Cambrensis Offprint*, 88, 237-346.
- Newcomb R.E., 1970. The Spatial Distribution of Hill Forts in West Penwith. *Cornwall Archaeology*, 9, 47-52.
- Ordnance Survey, 1962. Ordnance Survey Map of Southern Britain in the Iron Age. Chessington, Ordnance Survey.
- Pierson-Jones J., 1973. *Undergraduate Part II Thesis*, Unpublished Undergraduate thesis, Cambridge University.
- Ralston I., 2019. The Hillforts of Britain and Ireland - the background to the Atlas Project: an overview of the number of hill- and promontory-fort sites. In Lock G., Ralston I. dir. *Hillforts: Britain, Ireland and the Nearer Continent: Papers from the Atlas of Hillforts of Britain and Ireland Conference, June 2017*. University of Edinburgh, Archaeopress Archaeology,
- Rivet A.L.F., 1958. Some of the Problems of Hill-Forts. In Frere S. dir. *Problems of the Iron Age in Southern Britain : papers given at a C.B.A. conference held at the Institute of Archaeology, December 12 to 14, 1958.*. University of London, Institute of Archaeology, 29-34.
- Rozenfeld H.D., Rybski D., Andrade J.S., Batty M., Stanley H.E., Makse H.A., 2008. Laws of population growth. *Proceedings of the National Academy of Sciences of the United States of America*, 105, 18702.
- Rozenfeld H.D., Rybski D., Gabaix X., Makse H.A., 2011. The Area and Population of Cities: New Insights from a Different Perspective on Cities. *American Economic Review* 101, 2205-2225.
- Schmidt S., Maddison S. 2020. Percolation Analysis. R-package for percolation analysis. Open Science Framework, Center for Open Science [online] <https://osf.io/7extc/> [Accessed: 7th april 2021]
- Stauffer D., Aharony A., 1991. *Introduction to Percolation Theory*, Boca Raton, CRC Press.

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## Résumé

L'Atlas of Hillforts in Britain and Ireland est une base de données complète d'environ 3300 sites qui a été utilisée pour étudier leur distribution spatiale, à l'aide de méthodes modernes. L'étude se fonde sur une technique appelée 'analyse de percolation'. Elle a donné des résultats très intéressants montrant des grappes de « Hillforts » qui présentent des caractéristiques régionales distinctes. Cette technique est résumée avant de présenter les groupes qu'elle a générés et de commenter la nature de leurs variations régionales. Ceux-ci sont ensuite comparés à d'autres jeux de données pour mettre en évidence des dynamiques sur la longue durée. D'autres attributs du jeu de données sont utilisés pour suggérer des hiérarchies de sites. Une nouvelle technique d'analyse est utilisée pour identifier les sites d'importance dans les interactions commerciales. En conclusion, cette recherche montre un potentiel pour développer la compréhension des territoires socio-politiques au cours de l'âge du Fer.

## Abstract

The 'Atlas of Hillforts in Britain and Ireland' is a comprehensive database of ca. 3300 sites. This has been used to investigate their spatial distribution, using modern spatial analysis methods. The study uses a technique called Percolation Analysis. This has produced some very interesting results showing clusters of Hillforts that have distinct regional characteristics in Britain, and a quite different one for Ireland. This technique is briefly summarised, prior to presenting the clusters that this has generated and commenting on the nature of their regional variations. These are then compared with other datasets to show 'deep time' patterns. Other attributes from the dataset are used to suggest site hierarchies. A new analysis technique is also used to identify sites of importance in trade interaction. In conclusion there is considerable scope to take this research further to develop understanding of possible socio-political territories during the Iron Age.