GIS and Literary History: Advancing Digital Humanities research through the Spatial Analysis of historical travel writing and topographical literature

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ABSTRACT (ENGLISH)

Exploratory studies have demonstrated the benefits of implementing Geographic Information Systems (GIS) technology in literary and cultural-historical research. These studies have done much to affirm the power and flexibility of GIS technology as a resource for humanities scholarship. At the same time, however, these studies share a common limitation in that they tend to rely on the analysis of point-based cartographic representations. Such representations are suitable for modelling quantitative geographical phenomena, but they are inadequate for modelling qualitative human phenomena. This inadequacy constitutes a significant problem for researchers who aspire to analyse the geographical experiences and spatial relationships represented in works of literature, including works that contain accounts of travel. The present article proposes a solution to this problem by demonstrating how advanced spatial analyses within GIS such as Cost-Surface Analysis (CSA) and Least-Cost-Path Analysis (LCP) can be used to facilitate more nuanced interpretations of historical works of travel writing and topographical literature. Specifically, the article explains how GIS, CSA and LCP can be combined to build coherent spatial models of the journeys recorded in the works of three canonical eighteenth-century British travellers, each of whom composed influential accounts of their travels through the English Lake District: the poet Thomas Gray (1716–1771), the naturalist Thomas Pennant (1726–1798) and the agriculturist Arthur Young (1741–1820).

FULL TEXT

1. Introduction

Geographic Information Systems (GIS) technology has been at the forefront of research in the applied sciences since its inception during the 1960s. In the Humanities, however, the use of GIS has been much more sporadic. This latter trend can principally be attributed to the fact that only some Humanities disciplines routinely engage with the kinds of quantitative and geographical data that GIS were designed to analyse [Pickles 1995] [Bodenhamer et al. 2010] [Bodenhamer et al. 2015]. Thus, whereas specialists in the discipline of Archaeology have been employing GIS since the early 1980s [Aldenderfer et al. 1996] [Fotheringham, Brunsdon, and Charlton 2000] [Wheatley and Gillings 2002] [Conolly and Lake 2006] [Parker and Asencio 2008] [Okabe 2006] [Goodchild, and Janelle, 2010], in disciplines such as History, equivalent fields of digital research have only emerged over the past two decades [Knowles and Hiller 2008] [Gregory 2003] [Gregory and Healey 2007] [Knowles and Hiller 2008]. Within Literary Studies, the discipline with which this article is primarily concerned, the turn towards GIS has occurred even more recently and has been driven both by a growing interest in the study of space, place and landscape, and by the refinement of the application of quantitative methods and computational approaches in literary research [Moretti 2009] [Moretti 2007] [Moretti 2013] [Jockers 2013] [Tally 2013] [Donaldson and Murrieta-Flores 2015] [Gregory, Donaldson, Murrieta-Flores, and Rayson 2015] [Cooper et al. 2016].

These disciplinary trends in Literary Studies have been shaped by pioneering interdisciplinary scholarship which has enabled literary critics, theorists and historians to work with Geographic Information Scientists on projects that employ GIS in collaborative research. One innovation that has occurred as a result of this research is the implementation of GIS in the study of both individual literary works and literary corpora composed of several works.

This development has variously been labelled ‘Literary GIS’ (see [Cooper et al. 2016]). Notably, between 2007 and 2008 the British Academy-funded "Mapping the Lakes: A Literary GIS" project at Lancaster University tested the interpretive possibilities of using GIS to compare different literary accounts of the English Lake District: a mountainous region in north-western England that has particularly significant associations with British literature and art [Gregory and Cooper 2009] [Cooper and Gregory 2011]. More recently, research projects at the New University of Lisbon, Trinity College Dublin, ETH Zurich, the University of Edinburgh, Cardiff University and Stanford University have adopted similar approaches in order to explore the imaginative and affective geographies of writers and readers, and to examine how these geographies intertwine with one another [Alves and Queiroz 2013] [Travis 2015] [Piatti 2016] [Anderson and Loxley 2016] [Anderson et al. 2016] [Heuser et al. 2016]. The studies undertaken by these research projects have enriched our understanding both of specific geographies and of the potential of geospatial technologies, including GIS, as resources for literary and cultural-historical research.

At the same time, however, these studies share a common limitation in that they largely rely on the analysis of distribution maps and other kinds of point-based cartographic representations. Point-based mapping techniques are useful for plotting the position of fixed geographical features and for facilitating the implementation of methodologies such as point pattern analysis; but these techniques are also reductive in that they limit the real complexity of places as sites of social engagement and interaction. Although we are accustomed to thinking about places as being "static", or as being defined by fixed boundaries, their cultural significance is in fact defined by other factors, such as the interconnected flow of experiences that converge in them and the roles they play as nodes in larger spatial networks [Ingold 2009]. Point-based maps are suitable for structuring the analysis of quantitative geographical phenomena, such as proximity and scale; however, they are less adequate for structuring the analysis of qualitative human phenomena, such as the experience of visiting a place or of travelling from one place to another. This is a significant problem for scholars who are engaged in research that aspires to analyse the geographical experiences and spatial relationships represented in literary works and, even more specifically, in works of travel writing and topographical literature. Analysing such works requires us to consider how the accounts they contain are shaped not only by the experience of specific locations, but also by the experience of travelling *through* and *between* those locations. We need to come to grips with both of these types of experience in order to appreciate how the authors of the accounts we are reading encountered and apprehended the places and landmarks they describe.

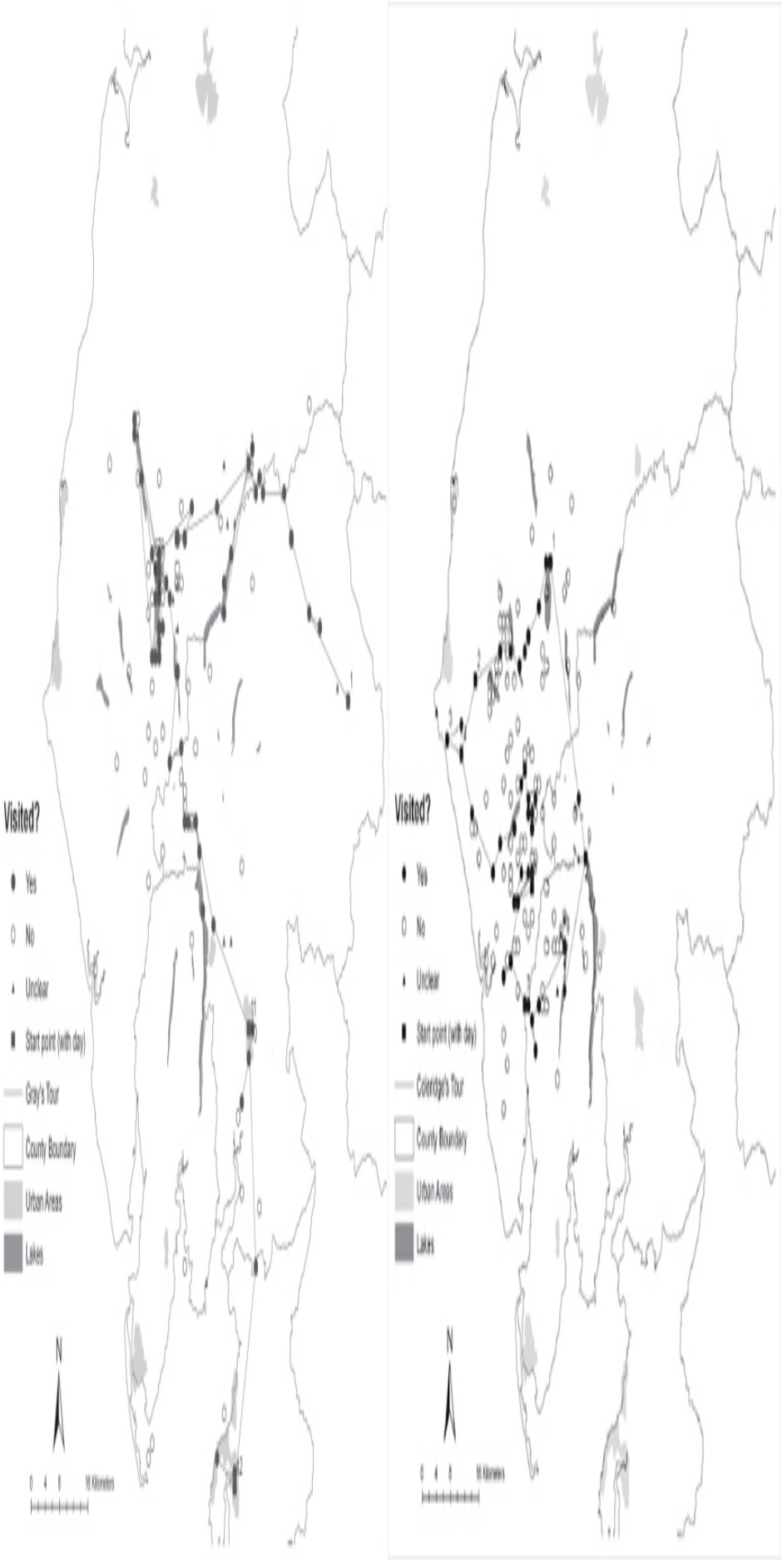
The present article proposes and models a GIS-based approach that can assist with structuring analyses that satisfy these requirements. In what follows, we shall demonstrate how advanced GIS-based spatial analysis, particularly Cost-Surface Analysis (CSA) and Least-Cost-Path Analysis (LCP), can facilitate more nuanced interpretations of historical works of travel writing and topographical literature. Our objective in the following pages shall be to combine these methodologies to perform a spatial analysis of the journeys recorded in the travelogues of three canonical, eighteenth-century British travellers: the poet Thomas Gray (1716–1771), the naturalist Thomas Pennant (1726–1798) and the agriculturist Arthur Young (1741–1820). The travelogues of Gray, Young and Pennant are diverse works, and they reflect the fact that these three writers undertook their journeys for distinctive reasons. For the sake of concision, we shall limit our analyses to the portions of Gray, Young and Pennant’s writings that concern the English Lake District, and we shall focus on employing GIS, CSA and LCP to investigate how the relative accessibility of the Lakeland landscape influenced both the routes these three travellers followed and, consequently, the experiences documented in their accounts.

2. Enhancing "Literary GIS" through the spatial analysis of historical travel writing and topographical literature

2.1 "Mapping the Lakes"

In engaging with a selection of historical works about the English Lake District, this article aims to extend and refine aspects of the research undertaken by the "Mapping the Lakes" project. The chief case study completed by "Mapping the Lakes" focused on two famous accounts of the Lake District. In that study, Thomas Gray’s Lakeland travelogue (written in 1769) was assessed alongside the letters and notes that a later writer, the Romantic poet Samuel Taylor Coleridge (1772–1834), composed during his ramble through the western fells of the Lake District in 1802. As the findings of this case study demonstrated, although Gray’s and Coleridge’s texts ostensibly contain

accounts of the same landscape, a GIS mapping of them reveals a set of radically divergent patterns (Figure 1).



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Significantly, these divergent patterns point up a number of the key differences between Gray's and Coleridge's excursions. Gray's tour was a fifteen-day trip by coach and horseback from Brough to Lancaster via the lakes of Ullswater, Derwentwater, Thirlmere and Windermere. Coleridge's tour, by contrast, was a nine-day odyssey taken on foot from his house in Keswick to the coastal village of St Bees, and thence famously over Scafell Pike to Eskdale and Coniston before returning homeward over Dunmail Raise. These contrasting routes indicate crucial differences in touristic attitudes and practices [Cooper and Gregory 2011, 93–95]. Gray's account, though famously one of the earliest documents of its kind, exemplifies many of the tendencies of later picturesque tourism in the Lake District. Gray travelled on coach roads in a planned route that took him through densely populated areas to sites of visual grandeur and beauty. Coleridge, by contrast, was a resident of the Lake District at the time he set off for the western fells, and his irregular route reflected his desire to avoid well-trodden paths. In short, whereas Gray was rather unabashedly what we would call a tourist, Coleridge regarded himself as a traveller (see [Buzard 1993] [Cooper 2012]).

2.2 Enhancing the study of historical travelogues through spatial analysis

In using GIS to ground these interpretations, the study completed by the "Mapping the Lakes" project confirmed that quantitative spatial approaches can play a meaningful role in the qualitative analysis of works of travel writing and topographical literature. Our current research into the implementation of CSA and LCP builds on these results, and it aims to enhance further the use of GIS-based methodologies in literary and cultural-historical scholarship. Our contention is that methods such as CSA and LCP can enable researchers to move beyond merely schematic point-based mapping techniques and towards spatial methodologies that are sensitive to the fact that places are characterised by much more than their geographic location.

As the map displayed in Figure 1 indicates, the "Mapping the Lakes" project used straight lines to represent the itineraries of Gray's and Coleridge's Lake District tours. Although this "connect-the-dots" strategy does portray the sequence of places that Gray and Coleridge visited, the geometrical depiction it produces gives us, at best, a superficial understanding of how the physical geography of the Lake District shaped the experiences documented in their accounts. Integrating CSA and LCP, we decided to undertake a more nuanced spatial analysis of a selection of key historical Lake District travelogues. Once again, we decided to focus on Gray's account, which was composed in 1769 as a series of epistles to his friend Thomas Wharton. But instead of working with Coleridge's account (which was written more than four decades later), we elected to draw on the accounts of two other writers who toured the Lake District at roughly the same time as Gray did. The first of these writers, again, is Arthur Young, who paid a visit to the Lakes whilst completing an agricultural survey of Northern England in 1768; the second is Thomas Pennant, who passed through the region as part of his tours of Scotland in 1769 and 1772.

Our decision to focus on Gray, Young and Pennant is not, however, solely based on chronology. It is, more significantly, based on the fact that they were the three chief authorities cited in Thomas West's highly influential A Guide to the Lakes (1778). A foundational work in the history of British tourism, West's Guide to the Lakes sold through an unprecedented eleven editions and was still being reprinted more than forty years after its initial publication. It was, accordingly, the work through which most late-eighteenth-century and early-nineteenth-century Lake District tourists first encountered Gray, Young and Pennant's writings about the region. Importantly, however, West's guide only reproduces portions of each of these writer's accounts of the Lake District and thus only gives a partial glimpse of the geographies of their Lakeland tours. In using LCP and CSA to investigate Gray, Young and Pennant's accounts of the Lake District, then, our aim was to achieve a better understanding of the experience of Lake District travellers in the era before the region was popularised by the works of writers such as West. More broadly, our objectives in spatially analysing the tours of these three writers were threefold:

1. In the first place, we wanted to assess the extent to which the Lake District's topography conditioned Gray, Young and Pennant's accounts by determining the degree to which the places each writer records having visited either corresponds to or deviates from the corridors formed by the natural contours of the region's terrain.

2. In the second place, our object was to compare Gray, Young and Pennant's accounts in order to ascertain whether they collectively or individually favoured particular parts of the Lakeland region, and (whenever a preference for a particular place or type of place could be discerned) to assess the reason for the writers' attraction to specific locations.

3. Finally, our goal was to employ GIS technology to create not only more accurate visualisations of the routes Gray, Young and Pennant followed, but also to examine the spatial relationship between these routes and the places Gray, Young and Pennant mentioned, but did not visit.

3. Simulating and analysing Gray, Young and Pennant's tours

3.1 Workflow and methodology

We shall proceed to explain the use of CSA and LCP momentarily. Before we do, however, we will first summarize succinctly the steps we took to meet each of our three objectives. The first step in this process was to create a GIS-readable version of the tours documented in Gray, Young and Pennant's accounts of the Lake District, and this itself involved several stages. First of all, we had to digitise the portions of each writer's account that dealt with the Lakeland region. This gave us a set of text extracts comprising [Gray 1775, 350–379] [Young 1770, III, 117–196] [Pennant 1771, 216–220] [Pennant 1774, 23–71].[1] Once we had prepared these extracts, we read them individually to identify and to record every place-name reference each extract contained. These place-names were then manually coded using XML and divided into groups to distinguish the places and landmarks that the writers visited from those they mentioned but did not visit. The places and landmarks tagged as having been visited were then arranged sequentially in a table to form an itinerary for each account. Once tagged, annotated and arranged in this manner, the place-names were geo-referenced using coordinate data from the Old Cumbria Gazetteer [Norgate and Norgate 2014]. The fully georeferenced dataset was then uploaded into ArcGIS. This dataset represents the geographic information contained in Gray, Young and Pennant's accounts as isolated points on the Lakeland landscape; however, it also provides a platform for performing more sophisticated forms of geographical analysis (such as CSA and LCP) in order to explore these accounts as records of movement *through* that landscape.

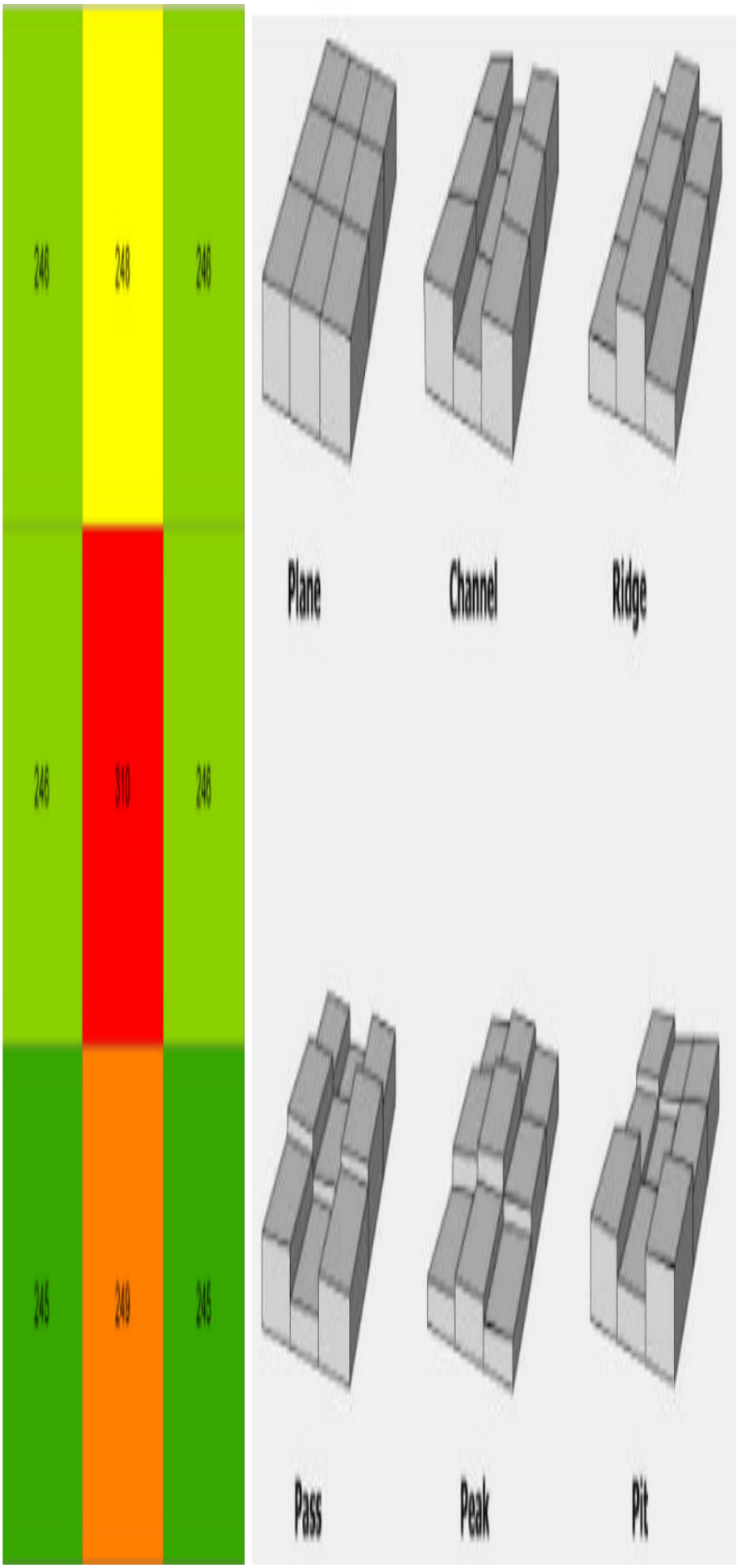
In order to achieve our first objective, we used CSA and LCP to simulate the natural corridors, determining the most efficient route for travelling over the terrain taking into account the relief of the Lake District's topography. We then implemented a spatial proximity test in order to assess whether the places in itineraries we had extracted from Gray, Young and Pennant's accounts were closer to the natural corridors formed by the region's topography than would be expected by chance alone. Performing this test allowed us to ascertain the relative accessibility of the places each writer decided to visit. In order to achieve our second objective, we simulated the routes most likely taken by the three writers according to the places they visited. Taking the journeys of the three authors into account, we then employed a Line Density Analysis (LDA) to identify the most frequented routes in order to determine whether there was a preponderance of attention given to any particular area or region. Finally, in order to achieve our third objective, we carried out another spatial proximity test. In this instance, however, we analysed the spatial relationship between the simulated pathways and those places that were mentioned in Gray, Young and Pennant's accounts, but which were not actually sites these travellers visited.

3.2 CSA and LCP

The use of CSA and LCP is well established in the applied sciences [Collischonn and Pilar 2000] [Yu et al 2003] [Adriaensen et al. 2003] [Atkinson et al. 2005] [Gonzales and Gergel 2007] [Howey 2007] [LaRue and Nielsen 2008] [Wang, Savage and Bradley 2009]. But this is the first time that these methods have been used in Humanities research to analyse the journeys recorded in historical travelogues. Admittedly, there are limitations to employing the

geospatial models that CSA and LCP create to study the accounts of historical travellers. Methods such as CSA and LCP are ideal for measuring the degree to which the routes taken by travellers correlate with the contours of the terrain those travellers are traversing. CSA and LCP do not, however, offer much in the way of insight about those traveller's attitudes towards the landscape through which they are moving or about the ideas they form whilst moving through it. As GIS-based methods, CSA and LCP rely on computational processes for which quantification is a prerequisite, and much of the information contained in works of travel writing (including feelings, sensations, and intuitions) is not necessarily quantifiable. Such limitations notwithstanding, CSA and LCP can contribute meaningfully to our understanding of historical works of travel writing and topographical literature. In particular, CSA and LCP can assist us with visualising the journeys such works describe, and they can alert us to geographical patterns that are not otherwise readily discernible. In sum, then, these methods are not a substitute for interpretation; rather, they are an aid for guiding critical inquiry and facilitating research.

CSA is a spatial methodology that allows one to determine the "cost" of travelling over a surface by considering not only Euclidean space, but also more complicated factors, such as slope and elevation. In other words, instead of limiting us to the examination of the Cartesian spatial properties of the data, it allows us to consider additional factors such as the contours of the terrain, as well as other variables (such as boundaries and borders) which influence how one moves through the landscape [Murrieta-Flores 2012]. The first step in creating a cost surface model in a GIS environment involves using a Digital Elevation Model (DEM), which is a raster image that represents the topography of the surface of the earth. Raster images, like DEMs, are similar to digital pictures; they are composed of pixels (or, more properly, cells) to which attribute information has been assigned. In digital pictures, this attribute information typically assigns a colour or shade to each cell. In a DEM, however, the attribute information assigned to each cell relates to the elevation of the portion of the earth's surface which that cell represents (Figure 2).



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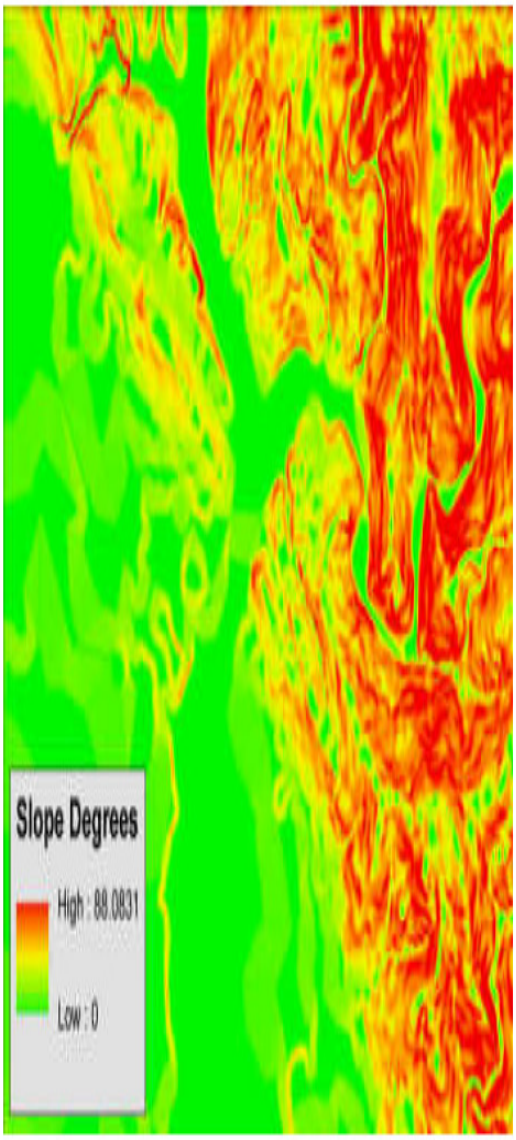
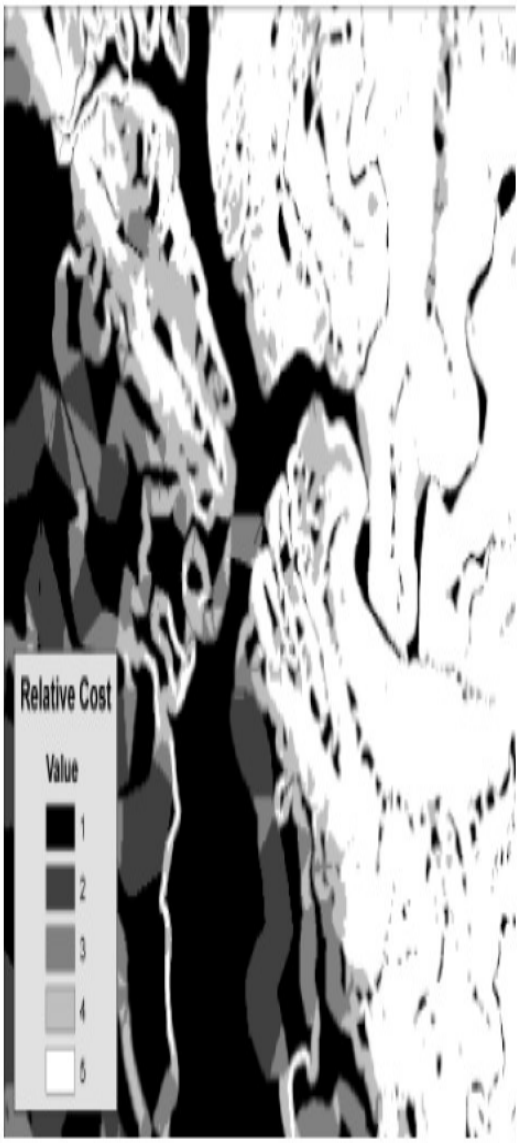
The second step in performing CSA is to establish the associated cost of traversing the terrain and any impediments

(such as rivers or bodies of water) it might contain. This is accomplished by creating a *friction surface.* Like DEMs, friction surfaces are raster images. In a friction surface, though, the cells that comprise the image contain information about the variables that influence the amount of effort it would take to travel across the terrain being represented. There are several cost functions that can be used to create a friction surface and to derive friction values [Herzog 2013]. The variables used in these functions can take a variety of different costs into account, such as the mode of transportation being used, the type of surface being crossed and the slope of the terrain [Fairén Jiménez 2004] [Fairén Jiménez, Cruz Berrocal, López Romero, and Walid Sbeinati 2006] [Fiz Fernández and Orengo, 2008] [Frachetti 2008] [Wheatley et al. 2010] [Murrieta-Flores 2012] [Yubero et al 2015]. These variables can also account for values based on other costs, such as the amount of weight the traveller is carrying or the speed at which the traveller is moving. The values of such costs are stored in each cell of the friction raster map, which is accordingly used to calculate the relative cost of traversing the terrain (Figure 3).





Slope Degrees		Relative Cost
0-2°	=	1
2-5°	=	2
5-10°	=	3
10-15°	=	4
15-88.09°	=	5

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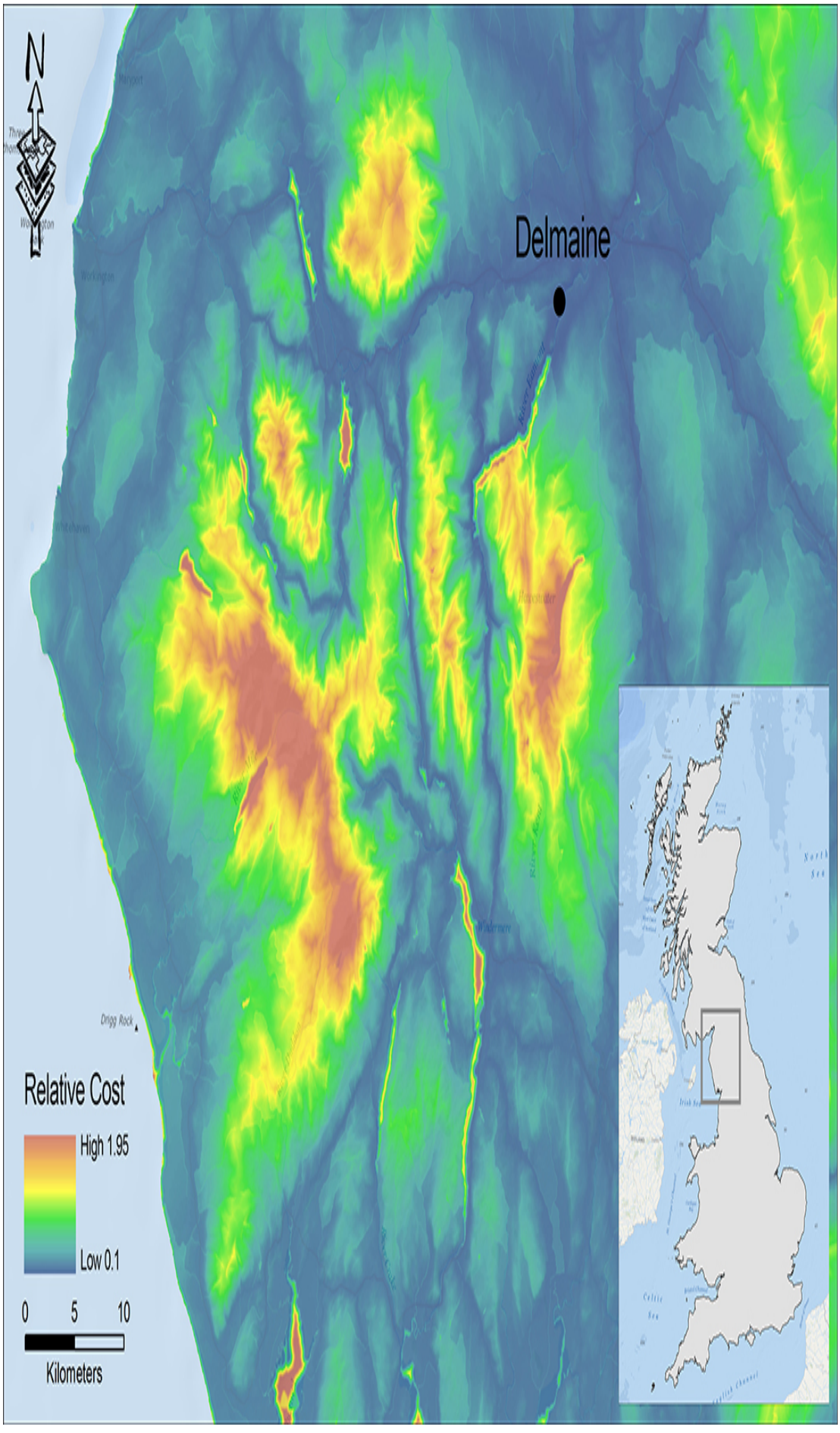
The third step in performing the CSA is to derive from the friction surface, a final *cost surface*. This is done by

calculating the cost of traversing the terrain from a source cell or point of origin. This source cell acts as a node from which to begin calculating the cumulative value of traversing the terrain. In this process, the adjacent cell with the lowest cost is searched for repeatedly until each of the cells has a cumulative cost value assigned to it [Stucky 1998]. The result is a raster image called "cost surface" that depicts the cumulative cost of travelling from a source or point of origin to any other location within the terrain represented (Figure 4). This step is performed multiple times to calculate the cost to travel from each location to any part of the landscape, which result in cost surfaces derived for each place investigated in the corpus.



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Once the cost surfaces have been established, one can then proceed with completing LCP. LCP is, essentially, a

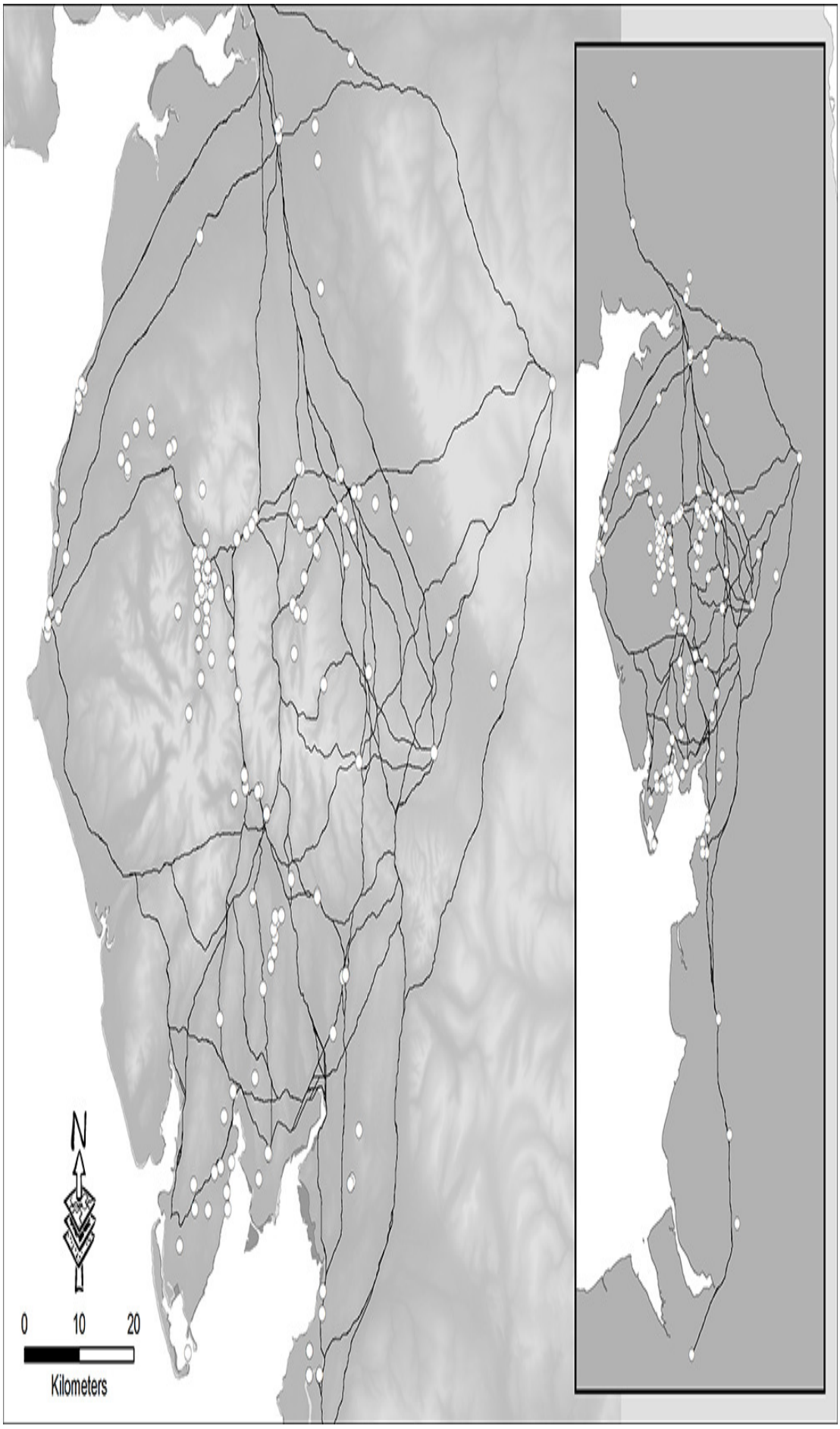
subsequent set of calculations that determines the path across the cost surface that will cost the traveller the least. The GIS is instructed to create a path across the cost surface following the adjacent cell with the lowest value assigned.

3.3 Implementing CSA and LCP

As with the cost surface, the paths that result from performing LCP analysis are dependent on the cost variables that were used to create the model. For the purposes of this case study, we created two anisotropic models using ArcGIS. Anisotropic models account for the direction of movement in the calculation of the cost, whereas isotropic models do not. It should be noted that for each of our experiments we made use of LCP, and that we created two different models in order to meet our objectives. In order to avoid confusion, when we discuss the results related to our first objective, we shall use the expression "natural corridors" to indicate those paths for which a model was designed to identify the least cost paths for the whole region. When we discuss the results related to our second and third objectives, we shall refer to either "simulated pathways" or "simulated itineraries" in order to describe the model that was designed to calculate the least cost paths for each of the authors' tours.

3.3.1 Objective One: The influence of topography

In order to investigate the degree to which the Lake District's topography may have conditioned the itineraries of Gray, Young and Pennant's tours, we calculated the least cost paths between the places each author visited. We accounted for three variables in these calculations: 1. the slope of the region's terrain; 2. the presence of bodies of water; 3. the direction in which Gray, Young and Pennant were each travelling (Figure 5). We then carried out a statistically based spatial proximity test in order to assess the spatial relationship between the places Gray, Young and Pennant visited and the Lake District's topography. In order to do this, we created a distance index for the accounts of each writer by calculating buffers of 500m from the natural corridors and then counting the number of visited places within each buffer (Figure 6). We then used this data to perform a statistical significance test (Kolmogorov-Smirnov). Our goal was to test whether the places Gray, Young and Pennant visited were closer to the natural corridors than one would expect by chance alone. The significance level set to test the null hypothesis was 0.01, and in all cases it was rejected. (As noted above, our goal here was to ascertain the degree to which Gray, Young and Pennant were influenced by a logic of optimality in their journeys: in other words, how closely they followed the natural corridors of the terrain.) This finding suggests that Gray, Young and Pennant did generally follow the natural corridors of the Lake District in their journeys and, accordingly, either that they were able to read the contours of the landscape successfully or, at least, that they were well informed about the most efficient ways to move between the locations through which they travelled.



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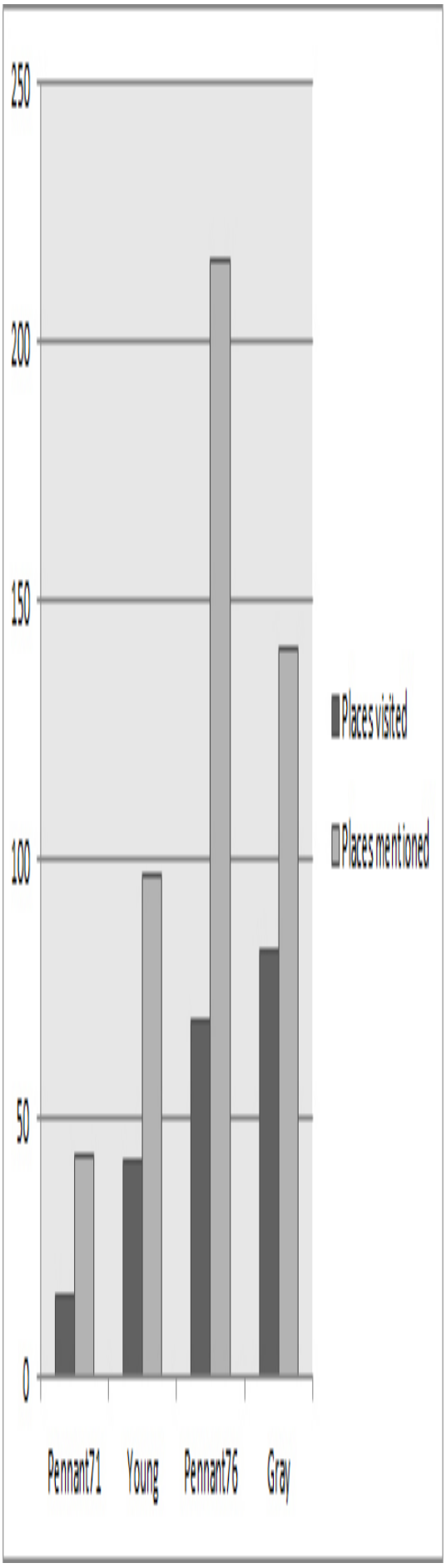

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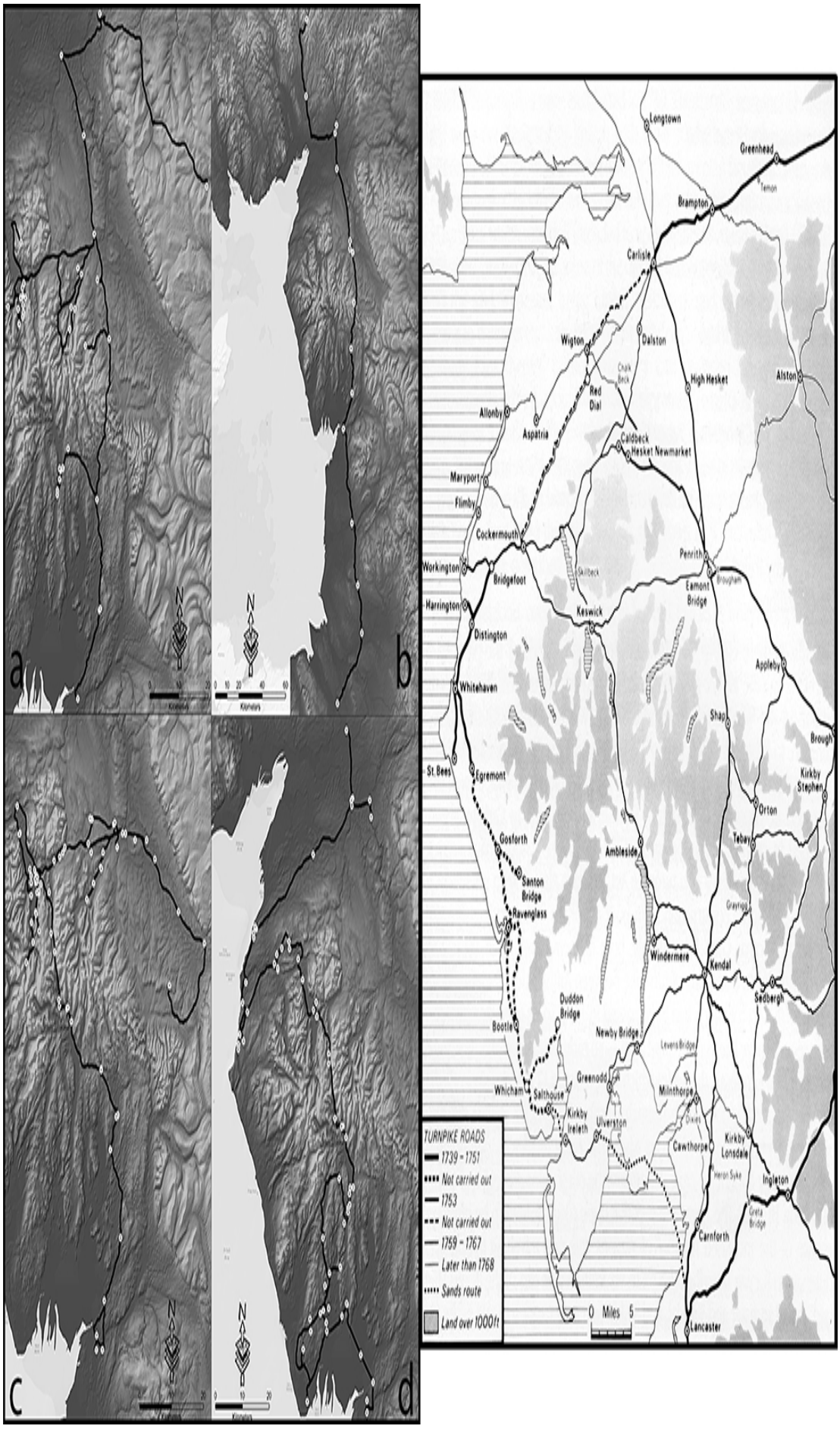
3.3.2 Objective Two: The influence of specific places

Having thus satisfied the first of our three objectives, we then proceeded to determine the extent to which Gray, Young and Pennant emphasised specific portions of the Lake District in their tours. In order to do this, it was necessary to construct simulations of the journeys documented in their accounts. We built these simulations by using each of the places in the itineraries we created for each writer as nodes, and then by using cost surface analysis to calculate the least cost path between these places, following the order in which they were visited (Figure 7). After we calculated least cost paths for each account, we then performed a LDA, which allowed us to identify those parts of the landscape through which each of the writers were likely to pass most frequently (Figure 8). Performing these analyses indicates that, collectively, Gray, Young and Pennant spent a significant amount of their time in the Lake District travelling around the lakes of Windermere, Ullswater and Derwentwater. We will offer additional commentary about these findings in the following section. But before concluding, it is worth noting that in addition to examining the locations Gray, Young and Pennant visited, we also performed an analysis on the places they mentioned but did not visit.



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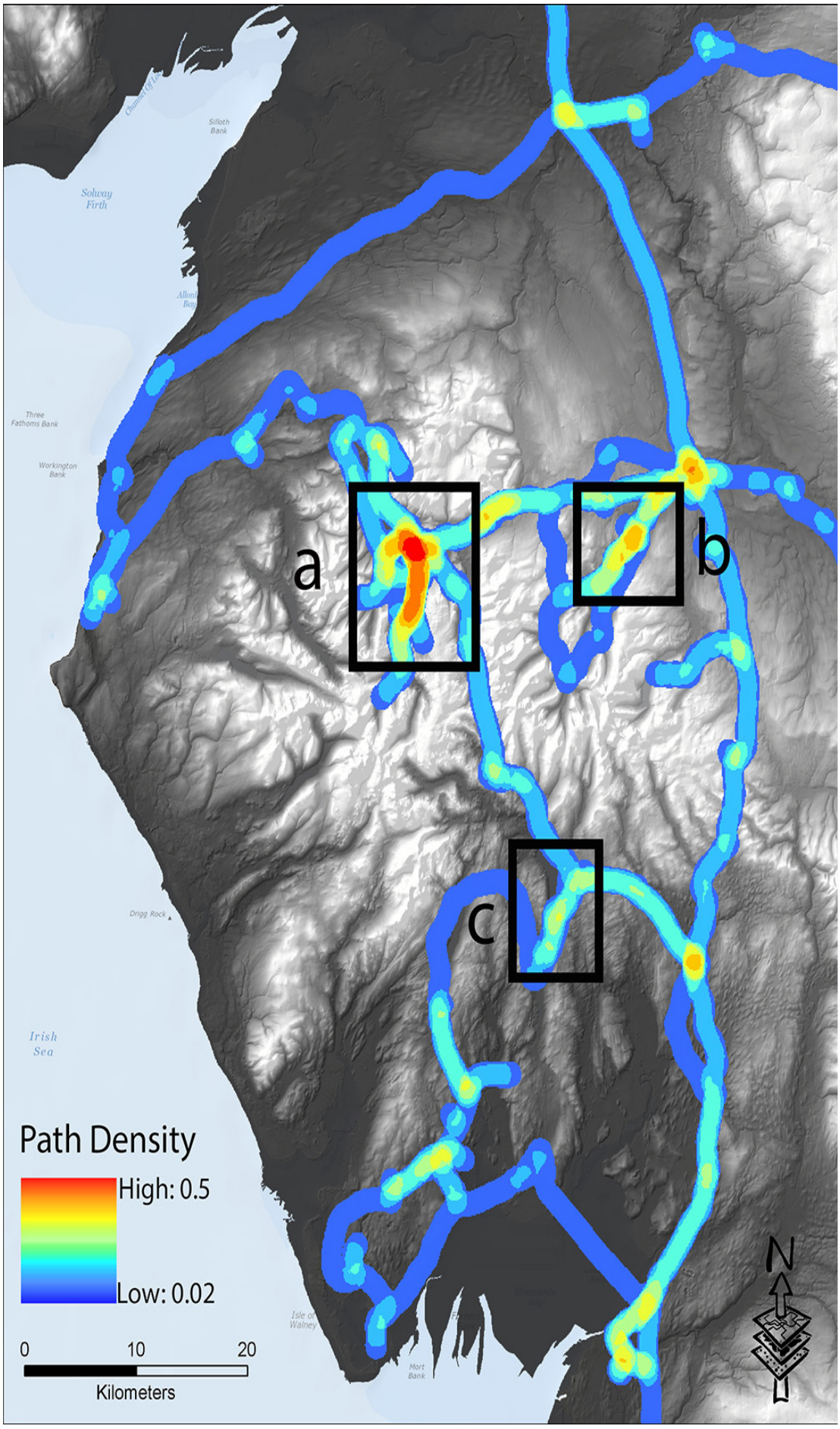

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3.3.3 Objective Three: The function of places mentioned, but not visited

Our intention, in this case, was to determine the role played by these unvisited places in the travel narratives presented in Gray, Young and Pennant's accounts. Accordingly, after we identified all the places in the four accounts that were mentioned but not visited, we then carried out another spatial proximity test. This time, the distance index for each writer was calculated with buffers of 1 km created from the itineraries simulated and the statistical test was also set to a significance level of 0.01. Our intention was to assess the degree to which the representation of the Lake District in each account was influenced by the places Gray, Young and Pennant visited and the degree to which it was influenced by places that they mentioned but did not visit. The results of this test indicate that the places mentioned but not visited in Gray and Young's accounts, and in Pennant's account of his tour of 1772, are closer to the routes they these writers followed than one would expect by chance alone. When it came to Pennant's account of his 1769 tour, however, the null hypothesis could not be rejected. As we explain below, this result clues us into an important aspect of how Pennant's 1769 tour stands apart from the other texts assess in this experiment.

4. Analysis and interpretation

We believe that the methods outlined above can facilitate more detailed analyses of how the records of historical travellers were shaped by the contours of the landscapes through which they travelled. What is more, to the degree that we accept those travellers' accounts as accurate descriptions of their journeys, these methods can furnish useful insights into how their accounts were conditioned by factors including the physical geography of the terrain, the existence of roads and tracks, and the availability of specific kinds of transportation. Our first spatial proximity analysis of the relationship between the tours and the Lake District's natural corridors demonstrates that all the places Gray, Young and Pennant record visiting are nearer to these pathways than would be expected by chance alone (Figure 5). In other words, although these three writers certainly visited a few places that could be considered remote —even adventurous —their itineraries still closely followed the natural corridors of the Lake District. (Indeed, as indicated in Figure 6, most of the places they visited fall within 500 metres of the region's natural corridors.)

These initial observations assist us in making some basic distinctions about the tours documented by Gray, Young and Pennant. For instance, they help us to discern that of the four accounts, the itinerary Pennant followed during his 1769 tour was the one that most closely adhered to the natural corridors of the region's topography. Comparatively, Young and Gray strayed farther from the Lake District's natural corridors. This finding makes sense, since in 1769 Pennant merely travelled along the outskirts of the Lakeland region whilst on his return from Scotland to his Downing estate. In his tour of 1772, Pennant visited other parts of the Lake District, particularly the Cumberland coast. Here again, however, the analysis shows us that, for the most part, he still followed the natural contours of the region's terrain.

Beyond enabling us to draw such basic distinctions, the spatial proximity analysis we conducted also helps us to perceive the correspondence between the Lake District's natural corridors and the routes that were present at the time Gray, Young and Pennant paid their visits to the region. Inasmuch, this analysis enables us to discern that, without exception, all three writers primarily relied on local carriage roads and turnpikes in their travels. At first glance this may seem a minor point, but it is of significant importance. Scholars [Andrews 1989] [Ousby 1990] [Powel and Hebron 2010] have long credited the accounts of early Lakeland travellers, such as John Dalton and George Smith, with attracting tourists to the region. At the same time, however, these scholars have generally paid less attention to how the improvement of local roadways during the 1750s and 1760s influenced the places to which those tourists were attracted. Brian Paul Hindle, one of the few historians to devote substantial attention to the early history of turnpikes in the Lake District, has observed that the influence of these improvements was twofold. They not only established standard routes that afforded swifter and safer access to several of the region's main

settlements (including Kendal, Keswick, Carlisle, Lancaster and Penrith), but also, in doing so, distinguished the places connected by, or at least visible from, these routes as the sites most worthy of the tourist's attention [Hindle 1998, 147–177] [Bouch and Jones 1961, 277–283] [William 1975].

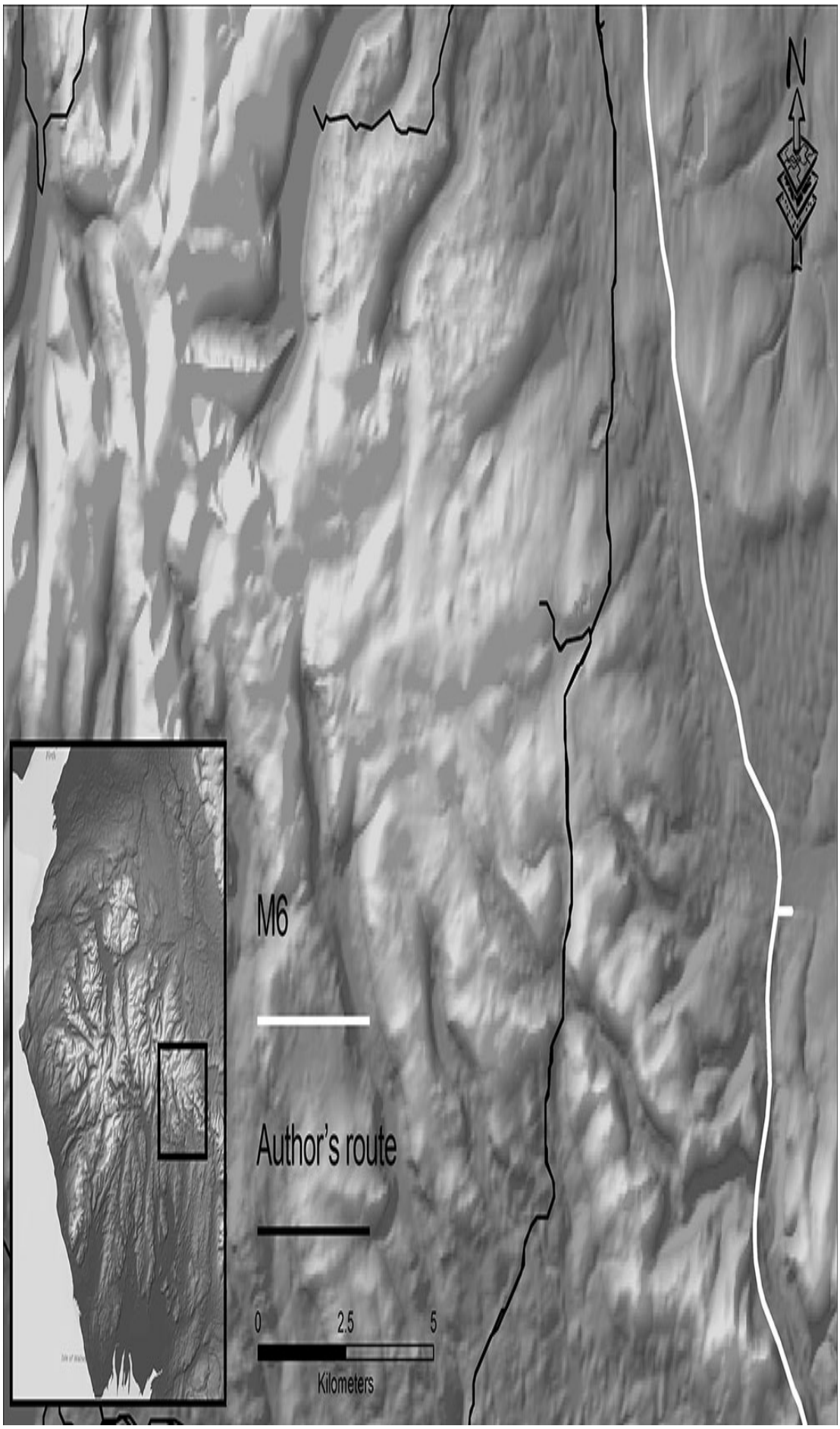
Accordingly, turning to Figure 8, it makes sense that the parts of the landscape through which Gray, Young and Pennant passed most frequently are located in the eastern half of the region (generally speaking, around the lakes of Ullswater, Derwentwater and Windermere), since these were the sites around which the majority of road improvements occurred. Incidentally, this also helps to explain why neither Gray nor Young nor even Pennant —who travelled through much more of Cumberland —set foot in the western valleys of Wasdale and Ennerdale. Although turnpike acts were passed to improve access to this area in 1750 and 1762, the roads in this remote part of the country remained in disrepair well into the nineteenth century [Hindle 1998, 154] [Hodge 1957, 67]. Indeed, whereas West, writing in 1778, could confidently declare that the roads throughout the Lake District had been "much improved since Mr. Gray made his tour in 1765 [sic], and Mr. Pennant his in 1772", as late as 1821 West's guidebook (then in its eleventh edition) still cautioned tourists that the roads leading to Ennerdale and Wasdale were, as yet, unimproved [West 1778, 2] [West 1821, 141]. Roads, in this way, can be seen to have exerted a decided influence over the cultural construction of the Lake District in the eighteenth century: they determined not only which portions of the Lakeland region travellers visited, but also the perspectives those travellers were afforded and, therefore, the descriptions of the region set down in their accounts.

So, in the first instance, Figure 7 shows us that Gray, Young and Pennant chiefly went where the local carriage routes and turnpikes enabled them to go. But how, we might ask, did those roadways shape their impression of the places through which they passed? Cultural historians have often remarked, with due amusement, that tourists in the late 1700s moved from scenic vista to scenic vista, collecting sensations in much the same way that modern tourists collect snapshots and souvenirs. Significantly, however, cultural histories of the Lake District tend to quote passages from eighteenth-century travelogues and guidebooks without commenting on the material conditions that determined the writer's point of view. Thus, whereas Gray's panoramic description of Grasmere's "peace, rusticity, and happy poverty" [Gray 1775, 365] is regularly cited as an archetypal display of picturesque sentiment, few scholars have noted that the poet's perspective of the town was determined by his having first seen it from the road over Dunmail Raise on a sunny autumn afternoon. This is precisely the sort of empirical detail to which reading the tours of Gray, Young and Pennant in relation to visualisations such as the one displayed in Figure 9 helps to alert us. The following examples, from Young's and Pennant's accounts of the journey over Shap Fell on the Heron Syke-Eamont Bridge turnpike, help to develop this point further:

Twelve of the fifteen miles from *Shapp* to *Kendal* are a continued chain of mountainous *moors*, totally uncultivated; one dreary prospect, that makes one melancholy to behold. [Young 1770, III, 169]

Pass over *Shap* Fells, more black, dreary, and melancholy, than any of the Highland hills, being not only very barren but destitute of every picturesque beauty. This barren scene continued till within a small distance of Kendal[.] [Pennant 1771, 219]

When read in isolation, these two passages might seem simply to reflect the late-eighteenth-century vogue for sensational landscape description. When we turn to the map, however, we begin to discern that they are as much shaped by the aesthetic conventions of their era as they are by the situation of the roadway that Young and Pennant followed. With a peak elevation of some 445m above sea level, the route of the old turnpike between Shap and Kendal is notorious for its isolation, exposure and poor weather [Hindle 1998, 157]. (Even today the M6 at Shap, which rises to only some 315m, is considered one of the highest and most treacherous stretches of road in the UK.) It comes as little surprise, then, that Young and Pennant found the landscape around Shap desolate and oppressive.


N
M6
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0
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5
Kilometers

Enlarge this image.

This is one of the benefits of using spatial models to study historical works of travel writing and topographical literature: it obliges us to examine local descriptions within the broader geographic context of the traveller's experience. Rather than thinking in terms of isolated places, the models we have developed emphasize that these writers were describing journeys from place to place. In doing so, these models help remind us that the experience of travelling in the Lake District in the late eighteenth century was not always pleasurable, but that it imposed upon the body in other ways, through the jolts of deep wheel ruts, the hazards of unpaved roads, the exposure to the wind and the rain and the mud. The fact that Gray, Young and Pennant take the time to record these details alongside the various scenes they encounter indicates the importance of the *experience* of travel in eighteenth-century travel writing and topographical literature. Young in fact goes so far as to include an appendix in the final volume of his Six Months' Tour, recording the condition of each stretch of road he travelled —often in exasperated detail. Hence, his damning account of the turnpike from Preston to Wigan:

I know not, in the whole range of language, terms sufficiently expressive to describe this infernal road… let me most seriously caution all travellers, who may accidentally purpose to travel this terrible country, to avoid it as they would the devil; for thousand to one but they break their limbs by overthrows or breakings down. They will here meet with rutts [sic] which I actually measured four feet deep, and floating with mud only from a wet summer; what therefore must it be [like] after a winter? …These are not merely opinions, but facts, for I actually passed three carts broken down in these eighteen miles of execrable memory. [Young 1770, IV, 180–81]

Carrying out a spatial analysis to obtain a more precise visualisation of the routes writers like Young might have followed helps put these sorts of commentaries into context.

In addition, the other GIS-based methods we employed allow us to analyse the role that particular places play in the geographies represented in Gray, Young and Pennant's accounts. For instance, by examining whether the places that were mentioned but not visited in these accounts have a significant spatial relationship with the paths simulating the itineraries of Gray, Young and Pennant, we can assess how the routes they travelled might have influenced the perception of the places and geographies recorded in their tours. The results of the statistical significance test indicate that places mentioned but not visited in Gray and Young's account, and in Pennant's 1769 tour, are closer to the routes than one would expect as a matter of chance alone (Table 1). In the case of Pennant's 1772 tour, however, the null hypothesis could not be rejected, indicating that there appears not to be a significant relationship between the places mentioned but not visited in his account and the simulated pathway we created from it.

This result is significant because it confirms how working with quantitative research techniques can clue us into the qualitative differences between historical works of travel writing. Specifically, it clues us into the fact that whereas Gray and Young's account, and Pennant's second account, are all accounts of journeys *into* the Lake District, Pennant's first account is actually only an account of a journey that *passed by* the Lake District. As mentioned above, in his first tour, Pennant simply travelled down the turnpikes linking Carlisle, Kendal and Lancaster on his way home from the Highlands. His account of the Lake District in the account he published in 1771 was, therefore, extremely cursory and only made reference to a few famous local places, most of which lay outside his line of travel. Significantly, however, Pennant returned to the region a few years later to view, as he expressed it in his memoirs, "those parts of Lancashire, Westmoreland, and Cumberland, which I had not before seen" [Pennant 1793, 16]. In this second tour (which was published in 1774) Pennant travelled through the Lake District in a manner similar to Gray and Young —hence, the statistical similarity between these three accounts.

Literary Text	Places Mentioned	Critical Value	DMAX	Null Hypothesis
Young 1770	29	0.24571	1.1	REJECTED
Gray 1775	94	0.140273	0.7444	REJECTED
Pennant 1776	23	0.125198	2.22	REJECTED
Pennant 1771	128	0.2749	0.029	NOT REJECTED

Table 1. Results from the Kolmogorov-Smirnov test assessing the relationship between places only mentioned and the itineraries of the authors.

Conducting this statistical test, then, enables us to draw a meaningful distinction between the four works in our case study. More generally, it prompts us to think critically about the role that places that were mentioned but not visited plays within each tour. That each of the four works contains references to such places indicates that the accounts of Gray, Young and Pennant are more than mere itineraries; rather, they are descriptive records that attempt to broaden the reader's awareness of the geography of the Lake District, which was still a relative terra incognita during the late eighteenth century. The fact that each account contains references to places that the writers did not actually visit suggests Gray, Young and Pennant all endeavoured to give their readers a sense of the surrounding countryside. In fact, when one turns back to the works themselves, one begins to see that the place-names that are mentioned but not visited are often invoked in panoramic descriptions. Thus, for example, Pennant's account of the mountains visible from the ramparts of Carlisle castle:

The castle is ancient, but makes a good appearance at a distance: the view from it is fine, of rich meadows, at this time covered with thousands of cattle, it being fair-day. The *Eden* here forms two branches, and insulates the ground; over one is a bridge of four, over the other one of nine arches. There is besides a prospect of a rich country, and a distant view of *Cold-fells*, *Cross-fells*, *Skiddaw*, and other mountains. [Pennant 1771, 217]

Elsewhere, one finds that place-names that are mentioned but not visited are also invoked in descriptions of trade, manufacturing and shipping. In these instances, the place-names are typically used to situate the industrial centres of the Lake District in relation to the economic geography of the nation. Hence, Pennant's observation [Pennant 1771, 217] that salmon from the River Eden are shipped to the markets in Newcastle and London, or, similarly, his later explanation of how Ulverston is connected, via Liverpool, with the slave trade:

Ulverston, a town of about three thousand souls, seated near the water side, and is approachable at high water by vessels of a hundred and fifty tuns [sic]; has a good trade in iron ore, pig and bar iron, bark, lime-stone, oats and barley, and much beans, which last are sent to *Leverpool* [sic], for the food of the poor enslaved *negroes* in the *Guinea* trade. Numbers of cattle are also sold out of the neighborhood, but the commerce in general declines; at present there are not above sixty vessels belonging to the place; formerly about a hundred and fifty mostly let out to freight; but both master and sailors go now to *Leverpool* for employ. [Pennant 1774, 29]

Significantly, one finds similar passages in Arthur Young's account, which was in large part a survey of agricultural productivity. Consider, for example, his account of the wool market in Kendal, where he uses place-names to refer to specific market centres as well as to specific breeds of sheep:

The wool they use is chiefly *Leicestershire, Warwickshire*, and *Durham*: They generally mix *Leicestershire* and *Durham* together. The price 8*d*. 9*d*. and 10*d. per lb*. They send all the manufacture to *London* by land carriage, which is said to be the longest, for broad wheel wagons, of any stage in *England*. [Young 1770, III, 171]

These observations, when viewed alongside the results from the second spatial proximity analysis, suggest that places that are mentioned but not visited played a number of important roles within the broader associative geographies of each text. They are invoked not only to describe the surrounding countryside, but also to document how places throughout the greater Lakeland region connect geographically, socially and economically with the wider world.

5. Conclusions

Although the use of spatial analysis in Humanities disciplines such as Literary Studies is still at an early stage, the application of geospatial technologies, such as GIS, has already begun to have a profound influence on the way literary scholars and historians approach the study of space, place and landscape. By implementing the geospatial methods employed in this study, for example, researchers can achieve new insights not only into the cognitive construction of geographies in literary works, but also into "fuzzier" phenomena, such as geographies of absence: places that are not specifically mentioned in a literary work, but nonetheless form part of its implied geography. In addition, the introduction of approaches such as Geographical Text Analysis [Leidner 2007] [Martins 2009] [Gregory and Cooper 2009] [Andogah 2010] [Buscaldi 2010] [Gregory and Hardie 2011] [Rupp et al. 2013] [Murrieta-Flores et al. 2015] [Porter et al. 2015] [Gregory and Donaldson 2016] has resulted in significant improvements in the automated extraction of geographical information from works of literature for the purposes of spatial analysis. As scholars in Literary Studies continue to adopt new computational methods, a growing number of researchers are also embracing GIS techniques to extract, examine and explore the spatial relationships embedded not only in works of non-fiction (such as those analysed above), but also in works of creative fiction as well as poetry and drama [Bushell 2016] [Murrieta-Flores and Howell 2017-Forthcoming].

The application of GIS technology in literary studies represents an important development. Until recently, however, little has been done to implement more creative approaches to mapping a writer’s movement through space. Advancing from point-based representations to the analysis of raster-based pathways is, therefore, a major step forward in the application of spatial technologies for studying works of travel writing and topographical literature. Such works are, after all, not merely descriptive inventories of places, monuments and buildings; they are narratives that offer first-hand accounts of the journeys of specific individuals. In order to visualise such works adequately we must employ techniques that are capable of representing the places they mention not as discrete locations, but as a series of interconnected points along the line of transit that constitutes the narrator’s tour. As noted at the beginning of this article, is only by assessing works of travel writing as journeys that we can understand how the writers of those works encountered the places and landmarks they described. Thus, with respect to Gray, Young and Pennant, it is only by tracing their journeys through the Lake District that we can hope to obtain insights into how the topography of the region —with its valleys, peaks and mountain passes —shaped the local experiences recounted in their travelogues.

The implementation of these methods, however, is as yet imperfect. One significant complication is that the data used to create the Digital Elevation Models (DEMs) used to perform CSA and LCP comes from modern sources (Lidar images and/or satellite or aerial photographs). This means that they contain the elevation data of modern roads, motorways and towns. Although the routes followed by eighteenth-century Lake District tourists often correspond to the routes of the modern road networks in Cumbria, in many instances there are significant differences between the two [Hindle 1998, 154–157]. The accuracy of our data could be greatly enhanced by the creation of historical DEMs. This could be accomplished by modifying and integrating to DEMs data from sources such as historical maps. Another important innovation would be the development of spatial models capable of accounting for more variables. The use of different modes of transportation and surfaces based on time instead of

relative cost might also furnish new insights into the empirical realities underlying travel narratives. Finally, one must remember that the development of CSA models still relies primarily on quantitative variables and that LCP is still based on a rationale of optimality, which is not always applicable to human behaviour. These are all issues that shall need to be addressed as humanities scholars and Geographic Information Scientists develop, extend and refine the application of geospatial technologies in humanities research.

Based on the study on which we have reported in this article, and the examples cited herein, we can confidently conclude that spatial analysis can facilitate more nuanced interpretations of works of travel writing and topographical literature. The process of creating a spatial dataset from the tours of Gray, Young and Pennant alerted us to details that most previous studies have overlooked. The simulations we created using this dataset have, moreover, provided the foundation for our on-going research into experimental forms of digital literary geography, such as using Google Earth to create interactive virtual tours. We believe that studies, such as the one presented here, can be productively combined with other emergent forms of geospatial technology to foster innovative collaboration between researchers in the Humanities and the Geographic Information Sciences.

Notes

[1] Pennant, as noted above, passed through the Lakeland region twice and thus provided us with two extracts.

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