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Geographical Information Systems and the Study of History

The articles in this special issue demonstrate the importance of employing geographical methodology and the study of spatial relationships for the reconstruction and reinterpretation of the human past. To that end, they explore a common theme of transport infrastructure and its effects on population distribution during the nineteenth and twentieth centuries in Europe, revealing the fresh results and perspectives that the use of geographical information systems (GIS) makes possible. Although the articles use different databases and draw upon methodologies specifically adapted for their respective locations, their approaches embody a distinct thematic unity.

Because of their versatility, GIS have become valuable resources for a wide range of purposes that have one element in common—the integration of a spatial component into a larger framework. GIS are composed of geographically referenced databases (providing exact locations) and the specific software to manipulate them. Each dataset corresponds to a subject that can overlap with others at any scale. This overlapping allows the discovery of further causal relationships within particular datasets. As a result of their theoretical and practical advantages, GIS applications have found their way into such disparate fields as transportation, logistics, public-health management, regional planning, environmental protection, archaeology, sociology, and economics (not to mention geography and history).[1]

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1 For more detailed information, see Timothy Bailey, "Historical GIS: Enabling the Collision of History and Geography," *Social Science Computer Review,* XXVII (2009), 291–296.

The first GIS data, dating from 1962, were collected and developed by the Canadian government to manage the country's natural resources. Not until the 1980s, however, did this technology reach the commercial sector. Thanks largely to the general availability of personal computers and information technology, GIS software eventually migrated onto efficient desktop applications. During the last decade, a number of free and flexible programs have improved and facilitated access to GIS. Furthermore, the visualization of GIS data via the Internet—Google Maps, Google Earth, OpenStreetMap, etc.—has become commonplace. A good example of a noncommercial, academic instantiation of GIS is "Vision of Britain," which includes data ranging from historical maps to election results.[2]

In historical GIS (HGIS), the subfield in which this special issue operates, the challenge is to add an analytical temporal dimension to a tool that is too often used to show only a series of static images over time. But the human eye cannot extract all of the information contained in an inert map series. Only recently has HGIS provided the means to analyze the interactions of relevant data in a specific area through time. The paragraphs that follow are intended to help readers gain a better understanding of what HGIS can contribute to the study of history.[3]

GEOGRAPHY AND HISTORY The need to combine temporal and spatial understanding is not new. Kant, a geography teacher during his youth, stated that human knowledge should be organized on three levels: (1) the classification of facts by subject (zoology studies animals; botany studies plants, and so on); (2) the organization of knowledge by temporal dimension—history; (3) the understanding of facts relative to spatial relationships—geography. The value of interrelating these three levels—blending geography and history, the better to determine the links between event, place, and time—is undeniable. However, nineteenth-century academics managed only to separate these two disciplines into faculties of natural science and arts. Despite the general demand for interdisci-

2 For "Vision of Britain," see http://www.visionofbritain.org.uk/.

3 As recently as 1998, Timothy Foresman, in *The History of Geographic Information Systems (GIS): Perspectives from the Pioneers* (Indianapolis, 1998), made no mention of works related to history. For HGIS, see Ian N. Gregory and Paul S. Ell, *Historical GIS: Techniques, Methodologies and Scholarship* (New York, 2007), 145–160.

plinary studies, field-specific interests often continue to encourage the persistence of these academic frontiers and to limit what exactly should be studied by each field.[4]

GIS applications offer a way of reconnecting history and geography. The emergence of new technologies favors a dynamic in which HGIS can serve as a meeting point between fields. The current state of the art provides useful tools for studying changes in time and space. The articles in this special issue show that HGIS meet historians' concern for reliable, detailed evidence. In historical GIS, the aim of collecting data for an entire study area—in this case, entire nation-states—requires the systematic incorporation of data from archives, printed materials, and previous empirical studies into temporal and territorial comparisons of events and trends. A good example of this kind of groundwork can be found in Healey and Stamp's "Historical GIS as a Foundation for the Analysis of Regional Economic Growth," a study of how railway development affected the iron and steel industry in Pennsylvania. Gregory and Ell's *Historical GIS* is also a useful guide for historians, geographers, and other professionals who seek to integrate a temporal dimension into their analyses. As these works show, HGIS produce novel results when brought to bear on the relationship between railways and economic activities; historical developments are revealed that would otherwise be left obscure or hidden.[5]

If HGIS allowed only the possibility of representing phenomena or spatial characteristics on maps, it would not constitute a significant contribution to the traditional work of geographers and historians. The potential of HGIS to lend new perspectives to spatiotemporal studies is twofold. First, it involves the creation of a locational database (data referring to a precise location in space) that multiple researchers interested in a particular subject or territory can use. Second, it enables an analysis of the elements in a database that transcends a simple cartographical presentation of data. In Gregory and Healey's words, "A key advantage of using GIS is its ability to include location explicitly into an analysis, enabling questions of pattern and distribution to be addressed. . . . GIS can

4 For Immanuel Kant on geography, see Fred K. Schaefer, "Exceptionalism in Geography," *Annals of the Association of American Geographers,* III (1953), 226–249.

5 Richard G. Healey and Trem R. Stamp, "Historical GIS as a Foundation for the Analysis of Regional Economic Growth: Theoretical, Methodological, and Practical Issues," *Social Science History,* XXIV (2000), 575–612.

aid the advancement of historical scholarship in three ways: first, by providing revisionist studies that challenge existing orthodoxies; second, by tackling questions that have not been resolved to date; and, third, by providing approaches that enable researchers to ask completely new questions."[6]

Kuhn's understanding of the paradigm changes that attend scientific revolutions is instructive regarding the evolution of geographical study. According to Kuhn, science does not advance in a linear way but through the upheaval of old ideas by new ones initially championed by only a handful of intellectual revolutionaries. In the case of geography, the dominance of the regional or neoromantic qualitative paradigm in the first half of the twentieth century was supplanted by a more positivist, quantitative one during the 1950s. That shift gave rise to important advances. At the end of the 1960s, the panorama changed again, in accord with a different political climate. The radical geography of the time coexisted with the quantitative movement, which was never as influential in geography as it was in, say, statistically oriented economic history. What geography and history have in common is the goal of discovering systematic ways of relating data to territories in order to give meaning to historical, or temporal, explanation. Although the appearance of GIS in the humanities and social sciences is not necessarily associated with either a positivist or an exclusively quantitative methodology, it could well import a significant change to historical research, particularly concerning new issues that need to be resolved.[7]

The traditional schism between geography and history has generated more problems than benefits. The articles in this special issue present results relating to several countries in Europe, within the context of a larger European Science Foundation (ESF) project combining a territorial and historical analysis of Europe over the last 150 years. Neither this nor any other approach based on HGIS constitutes a threat to qualitative work in history; it is, rather, a way of complementing it. Take, for example, two general contributions to the history of transport—Livet's *Histoire des routes et des transports en Europe* (2003) and Lay's *Ways of the World* (1992), both

6 For a concise presentation concerning the potential of a locational database, see http://www.hgis.org.uk/. Gregory and Healey, "Historical GIS: Structuring, Mapping and Analysing Geographies of the Past," *Progress in Human Geography,* XXXI (2007), 644.

7 Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago, 1962).

of which offer an integrated vision of how the evolution of transport systems affected social and economic activity. Their painstaking archival research does not employ map series to establish their syntheses and conclusions. Instead, they rely, with no loss of credibility, on technical, political, and economic matters, including wars, to trace the development of transport systems. In these and many other works about this subject on the national scale, maps support and illustrate ideas, but they do not ask, or contribute, anything new.[8]

Coherent and informative as such studies are, HGIS go a step further by compiling broad data series associated with particular points within a territory. Since each database also corresponds to related subjects (as municipal area is related to the evolution of population or to the presence/absence of a rail service), two new possible approaches rapidly and automatically emerge: (1) moving from local geographical analysis to a general analysis of a country or continent, because the data are comparable, and (2) providing statistical calculations between data series to identify causal factors over time. The most important contribution of HGIS is their close link to the preparation of an empirical base—adding numerical tests to the results and interpretations of an analysis.[9]

THE LITERATURE AND FUTURE PROGRESS OF HGIS HGIS have experienced considerable expansion in several key areas during the last ten years. This advance not only paves the way for further progress in the use of HGIS for the production of maps and specific spatial analyses; it also demonstrates the relevance of geographical data in explanations of economic and historical phenomena.[10]

In this regard, HGIS have already ventured into a wide range

8 For the larger GIS project—the History of European Integration (1825–2005): European Road and Rail Infrastructure—see http://www.tensionsofeurope.eu/Dissemination.asp?wh=Working%20Papers (2008_4). Georges Livet, *Histoire des routes et des transports en Europe: des chemins de Saint-Jacques à l'âge d'or des diligences* (Strasbourg, 2003); Maxwell G. Lay, *Ways of the World: A History of the World's Roads and of the Vehicles That Used Them* (New Brunswick, 1992). Other works include David Turnock, *Historical Geography of Railways in Great Britain and Ireland* (Aldershot, 1998); François Caron, *Histoire des chemins de fer en France* (Paris, 1997–2005), 2 v.; Antonio Gómez-Mendoza, *Ferrocarril: industria y mercado en la modernización de España* (Madrid, 1989).

9 Examples of points within a territory could be a city, a railway track, or the area of a municipality.

10 This line of work is not altogether novel; traces of it are evident as far back as August Lösch, *The Economics of Location* (New Haven, 1940).

of analyses: different scales of, and rationales for, spatial analysis (in China and Ireland, for example); the presentation of data sources, data components, and methodological issues; new ways of doing historical research; and detailed syntheses of recent trends in the field. Much of the material produced for Europe and other parts of the world employs cartography mainly to illustrate data and processes, but scholars have become increasingly interested in utilizing more complex information involving multiple layers of data. Some of this work has focused on Europe, both on a national and a continental level, dealing with such matters as local taxation and regional changes in population. Moreover, several countries have participated in the creation of a national HGIS project, resulting in specialized web pages, print publications, and, in at least one case, a general overview.[11]

11 For China and Ireland, see Merrick L. Berman, "Boundaries or Networks in Historical GIS: Concepts of Measuring Space and Administrative Geography in Chinese History," *Historical Geography,* XXX (2005), 118–133; Gregory and Ell, "Analysing Spatio-Temporal Change Using National Historical GIS: Population Change during and after the Great Irish Famine," *Historical Methods,* XXXVIII (2005), 149–167; for a presentation of data sources, William Block and Wendy Thomas, "Implementing the Data Documentation Initiative at the Minnesota Population Center," *Historical Methods,* XXXVI (2003), 97–101; for data components, Ric Vrana, "Historical Data as an Explicit Component of Land Information Systems," *International Journal of Geographical Information Systems,* III (1989), 33–49; for methodological issues, Gregory and Ell, "Breaking the Boundaries: Integrating 200 Years of the Census Using GIS," *Journal of the Royal Statistical Society,* CLXVIII (2005), 419–437; for new ways of doing historical work, *idem, Historical GIS;* Brandon Plewe, "The Nature of Uncertainty in Historical Geographical Information," *Transactions in GIS,* VI (2002), 431–456; Kurt Schlichting, "Historical GIS: New Ways of Doing History," *Historical Methods,* XLI (2008), 191–196; Anne K. Knowles, *Placing History: How GIS Is Changing Historical Scholarship* (Redlands, Calif., 2008); for detailed syntheses, Gregory and Healey, "Historical GIS: Structuring, Mapping and Analysing Geographies of the Past," *Progress in Human Geography,* XXXI (2007), 638–653; for cartography illustrating data and processes, Keith Lilley, Chris Lloyd, and Steve Trick, "Mapping Medieval Urban Landscapes: The deGISn and Planning of Edward I's New Towns of England and Wales," *Antiquity,* LXXIX, 303 (2005), at http://www.antiquity.ac.uk; Martina De Moor and Torsten Wiedemann, "Reconstructing Belgian Territorial Units and Hierarchies: An Example from Belgium," *History and Computing,* XIII (2001), 71–97; Martí-Henneberg, "The Map of Europe: Continuity and Change of the Administrative Boundaries (1850–2000)," *Geopolitics,* X (2005), 791–815; Scott Orford et al.,"George Davey Smithe, Life and Death of the People of London: A Historical GIS of Charles Booth's Inquiry," *Health & Place,* VIII (2002), 25–35; Peter Bol et al., *A Global Historical GIS (GH-GIS) Project* (Boston, 2009); on a national scale, Gregory and Humphery R. Southall, "Spatial Frameworks for Historical Censuses—the Great Britain Historical GIS," in Kelly Hall, Robert McCaa, and Gunnar Thorvaldsen (eds.), *Handbook of Historical Microdata for Population Research* (Minneapolis, 2000), 319–333; Gregory, "The Great Britain Historical GIS," *Historical Geography,* XXXIII (2005), 132–134; *idem,* "Different Places, Different Stories: Infant Mortality Decline in England & Wales, 1851–1911," *Annals of the Association of American Geographers,* XLVIII (2008), 773–794; on a continental scale, *idem,* "Time Variant Databases of Changing Historical Ad-

HGIS promise to evolve well into the future, preferably along lines of research that could define common objectives. To that end, a 2008 meeting organized in Essex (http://www.HGIS.org.uk/index.htm) included a discussion about the causal relationship between the development of the railway network and the distribution of population, which directly pertains to the findings reported in this special issue: Changes in the distribution of population are significantly related to a region's access to new means of transportation. In the nineteenth century, railways brought social and economic activity to previously barren areas and stimulated growth in areas that were already settled. Calculations of accessibility and changes in population density are therefore key indicators when measuring long-term inequalities in regional development. HGIS have much to contribute in this regard, but only by employing data that meet strict requirements. The technology for this kind of work is already largely in place. Having been consolidated during the last few decades, it is now expanding its interdisciplinary frontiers. GIS allow more and more users to share data, methodologies, and expertise.[12]

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ministrative Boundaries: A European Comparison," *Transactions in GIS,* VI (2002), 161–178; for local taxation, Donald DeBats, "Tale of Two Cities: Using Tax Records to Develop GIS Files for Mapping and Understanding Nineteenth-Century U.S. Cities," *Historical Methods,* XLI (2008), 17–38; for changes in regional population, Martí-Henneberg, "Empirical Evidence of Regional Population Concentration in Europe, 1870–2000," *Population Space and Place,* XI (2005), 269–281; for specialized webpages, http://e-geopolis.eu.); http://www.media-stat.admin.ch/maps/mapnify/start.php?map=zra_bevdichte&lang=fr; http://www.hgis.org.uk/index.htm; http://www.fcsh.unl.pt/memorias/atlas.php?lang=pt; http://www.europa.udl.cat; http://mesoscaphe.unil.ch/atlas/roumanie/pages/; for print publications, Catherine Fitch and Steven Ruggles,"Building the National Historical Geographic Information System," *Historical Methods,* XXXVI (2003), 41–51; Robert B. McMaster and Pétra Noble, "The U.S. National Historical Geographical Information System," *Historical Geography,* XXXIII (2005), 134–136; Gregory, "Longitudinal Analysis of Age and Gender Specific Migration Patterns in England and Wales: A GIS-Based Approach," *Social Science History,* XXIV (2000), 471–503; *idem,* "The Accuracy of Areal Interpolation Techniques: Standardising 19th and 20th Century Census Data to Allow Long-Term Comparisons," *Computers, Environment and Urban Systems,* XXVI (2002), 293–314; *idem* and Martí-Henneberg, "The Railways, Urbanisation, and Local Demography in England & Wales, 1825–1911," *Social Science History,* XXXIV (2010), 199–228; Eric Vanhaute, "The Belgian Historical GIS," *Historical Geography,* XXXIII (2005), 136–139; De Moor and Wiedemann, "Reconstructing Belgian Territorial Units and Hierarchies," 71–97; Luis Silveira, *Os Recenseamentos da populaçao portugesa de 1801 e 1849* (Lisbon, 2001); for a general overview, Knowles, "Reports on National Historical GIS Projects," *Historical Geography,* XXXIII (2005), 293–314.

12 For the common standards needed to regulate the GIS technology, see ISO regulations in Gregory and Ell, *Historical GIS,* 642.

GIS also have great protential as web-based teaching tools. The Internet stands ready to take full advantage of the basic interactive functionality of GIS systems through visualization and the search for information. Moreover, GIS would permit scientific institutions to collaborate with each other, as well as with other disciplines and interests, via the construction and dissemination of databases. Thus GIS are equipped to handle the demands of historical analysis in their concern with the origins, effective deployment, and reliability of data.[13]

POPULATION GEOGRAPHY AND TRANSPORT HISTORY, A CASE-STUDY IN HGIS The research program presented herein examines the joint evolution of railway expansion and population change, subjects usually treated in isolation from one another. Numerous studies have identified the railway as a crucial factor in the transformation of European society and its economy since the mid-nineteenth century, but the extensive bibliography about the European railway network's demographic and socioeconomic consequences is largely generic, devoid of interdisciplinary and systematic quantitative analysis. Another focus of this special issue is the changing pattern of population distribution in Europe, which scholars have examined from locational, historical, anthropological, and social perspectives.

Our guiding questions about railroads and populations in nineteenth- and twentieth-century Europe combine old and new historical problems: Did the new transport technologies favor the concentration or dispersal of population? How, and to what extent, did modern transportation influence rural depopulation? How quickly did the spatial restructuring of the population occur in different places and times? What were the similarities and differences between various countries and regions in this context? How can the effect of railway accessibility on a region's development be measured in both geographical and chronological terms? In other words, to what extent did the railway help to sharpen the process of territorial differentiation between regions and countries in Europe?

To pursue these questions, the authors of each article in this

13 For an example of interactive GIS on the web, see, for example, http://www.atlas-europa.de/—"Digital Atlas on the History of Europe since 1500."

special issue reconstructed the evolving railway network and population change in its study area. The timing and extent of railway expansion proved to vary considerably across the six national states under study. A few of the articles compare various countries (such as France with England and Wales, and the countries of the Iberian Peninsula). Others concentrate on a single country—Finland, Portugal, Turkey, or Bulgaria. The areas under study fall into one of two sample groups, Western Europe or Eastern/Southern Europe.

The initial situations, as far as available databases are concerned, vary greatly by country. In Finland, the administration had collected all of the relevant data, making it freely available. In Portugal, France, Spain, England, and Wales, prior research by the authors enabled the codification of population data, whereas the data on railways was compiled within the framework of the ESF research project. Finally, the analyses based on Bulgaria and Turkey required the authors to collect new data from censuses. These different starting situations also had an influence on the methodologies employed. In some cases, the calculations could build on those of previous studies; in others, the compilation and description of the data were totally new.

Each of the contributions starts from a quantitative base and performs an integrated analysis using GIS. The structures of the individual railway networks under investigation—their density and their rate of construction—are all different, as are the settlement patterns, the main characteristics of urbanization, and the rhythm at which change took place. Yet, the overall design of the collection maintains a balance between individual analyses and a common central thread, which was facilitated by the researchers' recent close collaboration on the ESF project. The articles have one feature in common; they combine the data relating to population for each country at the municipal level, as derived from official records dating from the first available census to the present day. They also deploy data about the various railway networks that were in service at ten-year intervals.

The authors reached subtly different conclusions about the extent to which the railway networks influenced patterns of population change over time. The effect is more pronounced in the countries with networks of the lowest density—Finland, Spain, and Turkey—where certain areas thrived to the detriment of oth-

ers. Yet, where the density was higher, the effect was more evenly spread throughout the area. In general terms, the authors agree that, over time, railway services contributed to an increase in the concentration of population. Although scholars have reached this unsurprising conclusion before, this study subjects it to rigorous measurement, detecting the effect with precision by conducting specific, long-term analyses. HGIS are uniquely capable of accomplishing such an objective.

In Kotavaara, Antikainen, and Rusanen's study of Finland, spatial statistical analysis reveals that an increasing percentage of the population settled in areas with good accessibility to railways. Silveira, Alves, Lima, Alcântara, and Puig's study of Portugal draws the same conclusion, also underlining how railways may have exacerbated conditions that previously hindered the development of areas with important structural weaknesses. Akgüngör, Aldemir, Kuştepeli, Gülcan, and Tecim accompanied their research about Turkey with a completely new database. Relating data about population at the municipal level with the development of the national railway system, they show how the concentration of railway tracks stimulated the process of urbanization. Kaloyan, Martí-Henneberg, and Ivanov's article on Bulgaria, which touches on regional and socioeconomic issues, makes similar discoveries about urban structure. This preparatory collection of data constitutes an important advance in this field of analysis and is a good precedent for future progress in the use of HGIS.

The remaining two contributions present the experience of more than one country. Schwartz, Gregory, and Thévenin's study of Great Britain and France offers a more in-depth exploration of the effects of railways on rural areas, suggesting that the availability of rail transport tended to slow rural out-migration for ten to twenty years after its arrival. Laia and Martí-Henneberg's analysis of France, Spain, and Portugal, which focuses more on urban areas, highlights the relatively few rail connections in Spain and Portugal, though the number has increased during the last fifty years. This situation contrasts sharply with that in France, which benefited from a much more intensive rail network. France, however, suffered from a serious curtailment of railway construction from the 1950s onward.

This group of studies forms part of the wider, ongoing, ESF project directed at the whole of Europe that requires a database ca-

pable of integrating precise information about railway networks and population—at both the regional and urban levels—based on census data. Clearly, any studies that follow these first attempts may well have to take into account altered national circumstances in Europe. The methodologies will have to be flexible enough to keep up with the changing geographical and historical mosaic of the Continent.

The territories under study are the result of long-term cultural, economic, and demographic processes. Geography cannot be understood without a time dimension, just as history cannot isolate itself from the location of the phenomena that it studies. Location conditions historical destiny. The first hypothesis underlying the ESF project is that European regional integration is a lengthy process that predates the European Union (EU) institutions. The degree of European integration needs to be measured state by state via the interconnectivity of transport networks and cross-border continuity, as illustrated with the help of sociodemographic indicators applied at both the regional and local levels. Thus it might be possible to evaluate the process of territorial integration at the pan-European scale empirically over long periods of time. Recent regional imbalances within the EU can be explained only by long-term processes of regional economic growth. The conclusions herein indicate that regional inequalities have increased in the light of long term-trends in the development and/or distribution of infrastructure and equipment, regional population inequalities, and economic growth.

In the academic sphere, the financing of research projects based on HGIS needs to be separated into the two work phases that are always required—that associated with the construction of spatial data and that relating to projects focused on interpretation and analysis. As in other disciplines from the physical/natural sciences, the labor of compiling databases in HGIS justifies self-contained projects that merit their own financing. In the humanities and social sciences, the highest value is attributed to interpretive results in which "narratives" play a relevant role. However, because the elaboration and distribution of databases do not carry much academic prestige, universities are often reluctant to support the production of extensive reference databases. One exception to this trend involves work in urban and economic history—both in its

narrative and quantitative forms—which has managed to achieve some measure of academic weight. Even so, this type of work tends to be general in nature (global and European), not comprised of large and small scales, as the databases associated with GIS are.[14]

Contributions in the field of HGIS, like the ESF project, are dual in nature. They not only relate directly to their avowed objects of study, but they also respond to previously constructed databases. The statistical services and national geographical institutes of particular European countries vary considerably. Of the nations represented in this special issue, Finland and Great Britain offered the greatest amount of pre-existing data available to the public, whereas Turkey and Bulgaria were at the opposite end of the spectrum, making any HGIS material obtained from them extremely valuable.

This special GIS-oriented issue is not the first of its kind; other journals have devoted space to GIS in one way or another. But this one is a milestone for being a complete thematic, methodological unit. The goal is to show historians how to integrate spatial analysis into their research, and to show geographers how to bring a historical dimension to their analyses, and perhaps even to recover a little respect. Many American universities have eliminated their geography departments, Harvard creating the most stir in 1948. The recent return of geography to Harvard—under the auspices of The Center for Geographic Analysis—largely by historians and within a broad-based program, owes much to GIS. Interdisciplinary collaboration may well be on the rise, as the most updated project shows.[15]

14 For work in urban and economic history, see Peter Flora, *State, Economy, and Society in Western Europe 1815–1975* (London, 1983–1987), 2 v.; Paul Bairoch, *Cities and Economic Development: From the Dawn of History to the Present* (London, 1988); Angus Maddison, *Contours of the World Economy, 1–2030 AD: Essays in Macro-Economic History* (New York, 2007); Brian R.Mitchell, *International Historical Statistics: Europe 1750–1988* (Hong Kong, 1992).

15 Other journals with special issues featuring GIS are *Social Science Computer Review,* XXVII (2009), 291–453; *Historical Geography,* XXXIII (2005), 1–167 ("Emerging Trends in Historical GIS"); *History and Computing,* XIII (2001) (http://quod.lib.umich.edu/cgi/t/text/text-idx?c=jahc;idno=3310410.0013.1*); *Social Science History,* XXIV (2000), 451–652 ("Historical GIS: The Spatial Turn in Social Science History"). Thomas Glick, "Before the Revolution: Edward Ullman and the Crisis of Geography at Harvard, 1949–1950," in John E. Harmon and Timothy J. Rickard (eds.), *Geography in New England* (New Britain, Conn., 1988), 49–62; Bol and Jianxiong Ge, "China Historical GIS," *Historical Geography,* XXX (2005), 150–152. For the Global and Historical GIS Project (GH-GIS), see http://sws1.bu.edu/jgerring/documents/GlobalhistoricalGIS_Project.pdf.

ADDITIONAL READINGS

GIS PORTALS

HumanitiesGIS.org provides abundant information about GIS, and the Stanford University Library has a list of humanities GIS resources, most of which are historical.

GIS AND LITERARY THEMES

"Mapping the Lakes: A Literary GIS" uses GIS to map early tours around the English Lake District (http://www.lancs.ac.uk/mappingthelakes/).

"Quakers in the North-West of England" contains texts and images of George Fox's journal and other material relevant to the Quakers (http://www.north-west-quakers.org.uk/).

"Hall of Taiwan Folk Literature" contains a range of material, most of it in Chinese (http://cls.hs.yzu.edu.tw/tfl/eng/eng_About1.aspx).

GIS IN PERFORMANCE AND FILM

Records of Early English Drama (REED) (http://link.library.utoronto.ca/reed).

"Mapping Performance Culture: Nottingham 1857–1867" (http://www.arts-humanities.net/projects/mapping_performance_culture_nottingham_1857_1867).

"Mapping The City in Film: A Geohistorical Analysis" (of Liverpool) (http://www.liv.ac.uk/lsa/cityinfilm/index.html).

HUMANITIES ATLASES

"The Map of Early Modern London" combines a map of London with significant amounts of textual information about streets, places, and literary references from the period (http://mapoflondon.uvic.ca/).

"Central Region Humanities Center@Ohio University" is developing a "humanities atlas" of Indiana, Michigan, Ohio, Kentucky, and West Virginia (http://www.ohio.edu/crhc/pathseeker.html).