

Historical Uses of GIS

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Emerging trends in HGIS

What is “historical GIS”? In other work, I have called it a methodology.¹ By this definition, any historical research that employs geographic information systems could be considered historical GIS. Over the past decade, however, historical GIS has also begun to take on the identity of a practice or sub-field within historical scholarship. As an emerging field, historical GIS has a number of distinctive characteristics:

1. Geographical questions drive a significant part of the inquiry;
2. Geographical information provides a good share of the historical evidence;
3. The bulk of evidence, or the evidence that provides the study’s key analytical framework, is structured and analyzed within one or more databases that record both location and time; and
4. Authors present key historical arguments in maps, particularly maps that visualize previously unknown or unexamined spatial relationships or patterns of change over time.

Although historians are using GIS to study a tremendous variety of subjects, periods, and places, three broad areas of research and resource creation account for a great deal of current activity. One is empirical research on the history of land use in relation to human settlement and economic change. Another is the use of GIS to visualize past landscapes and the changing morphology of the built environment over time. The third consists of infrastructure projects that aim to make historical-geographical source materials available to scholars and the general public. From what I understand, PACSCL’s geohistory network fits readily into the second and third categories. I will focus my remarks on those parts of the field.

To touch briefly on the first category, environmental historians and political ecologists are doing some of the most interesting and intellectually challenging historical GIS today. Two exemplary books by historians are Geoff Cunfer’s *On the Great Plains: Agriculture and Environment* and Brian Donahue’s *The Great Meadow: Farmers and the Land in Colonial Concord*. Both of these scholars use intensive, empirical mapping of

land use and environmental conditions to re-examine long-standing historical interpretations of American agricultural history. Donahue finds that colonial farmers in Concord did not mine the soil, as historians have long contended they did. Similarly, Cunfer finds that Plains farmers actually paid pretty close attention to the limits of agriculture in a semi-arid environment. In both cases, farm families acted for the most part as responsible stewards of the land, even as they adjusted their land-use practices in response to changes in climate, market, and family needs.² Cunfer and Donahue's studies demonstrate that GIS can reveal the almost infinite variety of land use while identifying spatial patterns that raise compelling questions.

There are probably more projects that involve visualizing past landscapes. Some efforts in "geovisualization" strive for verisimilitude for its own sake, inspired by the beguiling realism of computer animation in cinema and gaming. But the digital reconstruction of historical landscapes can also serve scholarly purposes. It is a particularly stimulating approach for classroom teaching and community history.

Cities lend themselves to geovisualization because large-scale urban maps and street plans provide rich historical information as well as handsome backdrops for visualizing the past. Technically speaking, urban maps are the easiest historical maps to georectify (to align with present-day geographical coordinates for use in GIS) because they cover a relatively small area and were often based on careful surveys. David Rumsey has introduced many readers to the seeming wizardry of digitally "rubbersheeting" historical maps so that one can almost perfectly overlay maps from different eras and then adjust the transparency of the layers until the maps' evidence of urban change rises magically from the page.³ Having scanned a historical map at high resolution and georectified it, one can pluck off information to create GIS layers for analysis or to highlight salient features on the historical map base. One can also add information gathered in the field, such as the GPS locations of historic buildings (a popular class exercise) or add information from other historical sources, such as the location of London coffeehouses or New Orleans jazz clubs.

Growing numbers of historians, geographers, and scholars in other fields are using GIS to create digital urban landscapes to study cities' changing morphology over time. Keith Lilley leads a group of researchers at Queen's University Belfast who are

using quasi-3D renderings of medieval towns in Wales to determine whether the towns' construction was adjusted to suit local topography or followed quite rigid ideal forms. Roy Bradshaw and Robert Abrahart are building a "digital Derby" whose ultimate goal is to capture, connect, map, and make accessible the whole historical geography of the nineteenth-century city.⁴ Loren Seibert's vision for a "GIS spatial history" of Tokyo is even more ambitious, as it includes physical features and topography, land cover and land use data, the history of urban planning and land division, as well as political, social, and economic change since 1900.⁵

Not all "virtual cities" are built with GIS. Digital London, Digital Prague, and other virtual urban websites have been created by architects and graphic designers using software that better simulates the dimensionality of streetscapes and the texture of building materials, or that models certain kinds of urban functions.⁶ Differences between GIS-based projects and projects built on other platforms are blurring in both directions as GIS users become more interested in visualization techniques and strive for more realistic effects in the historical landscapes they render.⁷

The third major area in historical GIS is infrastructure projects that generally aim to facilitate the use of GIS in historical research. More than a dozen national historical GIS projects lead this part of the field.⁸ The Great Britain Historical GIS was the first to be completed. Like most such projects, the GBHGIS consists of carefully researched administrative boundaries (the spatial component of the database), which are linked to demographic information derived mainly from published census reports (the tabular data). Reconstructing historical boundary changes over time requires painstaking research, but it is work that quantitative historians in particular feel is worthwhile. For example, only with historically accurate boundaries can one derive population density correctly.⁹ Knowing to which county a place belonged in a given period is also necessary for finding locally held records. While national historical GIS projects thus far are intended primarily for social science research, some large infrastructure projects have a more humanistic bent. Religious history figures prominently in projects supported by the Electronic Cultural Atlas Initiative, for example, and the Pleiades Project is a GIS-based, collaborative digital resource for research on the ancient world.

Many of today's historical GIS studies are the first to map important primary sources or to capture and explore all the geographical information a primary source contains. This is the most exciting thing about historical GIS for many scholars – the “eureka” moment when someone sees interesting data mapped for the first time.¹⁰ Relatively few historical scholars to date have used the spatial analytical functions of GIS that geographers emphasize, and most of those who have have collaborated with GIS experts.¹¹ The sophisticated blending of spatial and statistical analysis that Amy Hillier demonstrates in her work on redlining in Philadelphia will doubtless become more common as graduate students gain facility with GIS.

Technical sophistication, however, is not a reliable gauge of intellectual significance. The mapping of distributions can have the force of revelation in history. Geoff Cunfer's argument that the Dust Bowl was caused by drought, not overplowing, is based on simple maps that show land use and climatological measurements by county. Brian Donahue is the first scholar to map land use in colonial New England at a scale that reveals whether farmers were or were not sensitive to the agricultural potential and constraints of their land.

The process of translating historical sources into GIS can be a complex, often taxing work of scholarship in itself. It can take years to develop an HGIS database to the point of producing results. In addition to the familiar tedium of data entry, one faces problems of determining the geographical location of the data one wishes to map, reconciling data formats, finding or creating appropriate base maps, and learning how to use software that is infamously poorly explained by GIS manufacturers. Extracting data from historical sources is analogous to data mining, but it is mining done with pickax and shovel at the rock face; it can rarely be automated. One must understand a source's provenance, the mentality that produced it, its inherent biases, and the points on which the information is most and least reliable. Such deep engagement with historical sources and their geographical context can lead to highly creative scholarship.

Difficulties scholars commonly encounter when they attempt to use GIS in historical research

The three biggest hurdles to historical GIS are dealing with unfamiliar geographical sources (maps), finding or making adequate historical base maps, and facing the stiff challenge of learning how to use GIS software.

Example: Say a scholar wants to map the growth of textile manufacturing in Greater Philadelphia. This would normally require one to:

- Find city directories for Philadelphia, Manayunk, and other urban places, which may or may not cover the same years;
- Geocode factory addresses from the directories, which for this (and most) nineteenth-century industries means coping with the address shift in Philadelphia's street numbering system;
- Find historical city street maps that cover all the places you want to include in your study at appropriate dates (both unlikely);
- Connect industrial production data to the factory addresses, entering data from the federal Manufacturing Census or manuscript firm records into a spatially referenced database.

In addition to traditional archival skills, this research requires one to create a relational database, geocode locations that may be difficult to verify, rubbersheet various historical maps to a common base, build a gazetteer, and learn enough about GIS to analyze the data once it is entered and copasetic. Then comes map design. I don't mean to discourage anyone. But this cocktail of skills indicates why HGIS projects can benefit greatly from cross-disciplinary collaboration. Few individuals possess the skills of a computer scientist, spatial analyst, and cartographer.

What would benefit HGIS scholarship most? My wish list for one-stop shopping for historical research on greater Philadelphia:

- A. High-resolution scans of historical maps, compressed for quick downloading. Each map should come with full carto-bibliographic documentation of the original and how it was scanned.
- B. Georectified historical maps. These should always be provided along with the unrectified original and full documentation of how the rectification was

done. Ideally, this might even include provision of the control points or digital reference layers used in the georectification.

If you hear a drum-beat here, you're right: *full documentation of the sources that go in to digital materials* will help scholars enormously. Most historians find GIS metadata forms cumbersome at best. They were designed by computer scientists and GIS manufacturers, not scholars, least of all humanists. The terminology of metadata is nearly impenetrable to non-specialists. While GIS users should learn what industry-standard metadata means, I suggest that PACSCL also consider providing traditional bibliographic documentation that includes additional information necessary for documenting sources' use in GIS.

C. Place-based searching

1. *Locality* – placenames indexed in a digital gazetteer that gives alternate spellings and names for known places.
2. *Location* – geographic coordinates of the locality so that it can be more easily and accurately mapped in GIS (centerpoint and/or geographic extent)
3. *Spatial context* – a nested index of the geographical entities to which a place has belonged, such as a neighborhood and its township, SMA, and county or counties.

D. Administrative units over time, again with full documentation of sources and method of creation.

E. Other base layers, which could be donated by scholars upon completion of their projects. If PACSCL does not want to become a repository for digital data, you could simply maintain a list of GIS projects bearing on the region's history.

The last item on my wish-list for historical GIS scholarship is that resource providers such as PACSCL would also provide technical and conceptual assistance to help

researchers design their projects. Academia Sinica in Taiwan offers an excellent model. The *Taiwan History and Culture and Time and Space* project, spearheaded up by historian Fan I-Chun, has developed historical base maps, demographic data, and environmental layers for mainland China and Taiwan that are available freely on the Web. In addition, the project's historians and GIS experts are available to meet with researchers to help them think through their projects from the ground up, and to help them find the resources and training they need.

Conclusion

Finally, two closing thoughts. A potential obstacle to the development of an ambitious, wide-ranging geohistory network for Greater Philadelphia is the relative scarcity of geographers in this metropolitan area and in the Mid-Atlantic more generally. Because geography is so under-represented in East Coast universities, scholars and archivists in this part of the country sometimes do not think to draw upon geographers' disciplinary expertise. Find the geographers in your midst; get them involved in this venture.

I hope you will all entertain a broad notion of what constitutes geographic information. It is great to start with maps and images of the built landscape, as these sources provide the basis for urban history, studies of neighborhood change, economic development, architectural history, and more. But there are many other sources of geographic information – in fact, almost any kind of historical document includes geographic information. How to bring the geographical content of historical materials to the attention of researchers is a fascinating challenge.

¹ Anne Kelly Knowles, "Emerging Trends in Historical GIS," in Knowles, ed., *Emerging Trends in Historical GIS*, *Historical Geography* 33 (2005): 7-13; "Introducing Historical GIS," in *Past Time, Past Place: GIS for History* (ESRI Press, 2002): xi-xx.

² Brian Donahue, *The Great Meadow: Farmers and the Land in Colonial Concord* (New Haven: Yale University Press, 2004); Geoff Cunfer, *On the Great Plains: Agriculture and Environment* (College Station: Texas A&M Press, 2005).

³ Rumsey and Williams, "Historical Maps in GIS," 8-16. See also Rumsey and Edith M. Punt, *Cartographica Extraordinaire: The Historical Map Transformed* (Redlands, Cal.: ESRI Press, 2004).

⁴ Keith Lilley, Chris Lloyd, and Steven Trick, "Mapping and Analyzing Medieval Urban Landscapes in GIS," and Roy Bradshaw and Robert J. Abraham, "Widening Participation in Historical GIS: The Case of Digital Derby 1841," RGS-IBG Annual International Conference, London, 1 September 2005.

⁵ Loren Siebert, "Using GIS to Document, Visualize, and Interpret Tokyo's Spatial History," *Social Science History* 24:3 (2000): 537-574.

⁶ Urban planners have also developed programs such as Space Syntax, developed at University College London, that measured spatial segregation and modeled spatial flows years before standard GIS programs were capable of such modeling.

⁷ See, for example, Trevor M. Harris, "GIS in Archaeology," in Knowles, ed., *Past Time, Past Place*, 131-143.

⁸ For summaries of representative projects, see "Reports on National Historical GIS Projects," in Anne Kelly Knowles, ed., *Emerging Trends in Historical GIS*, *Historical Geography* 33 (2005): 134-158.

⁹ Ian N. Gregory's many publications on the GBHGIS and the statistical significance of historically accurate boundaries are summarized in *A Place in History: A Guide to Using GIS in Historical Research*, <http://hds.essex.ac.uk/g2gp/gis/index.asp>. On the modifiable areal units problem, see Stan Openshaw, *The Modifiable Areal Unit Problem*, CATMOG (Concepts and Techniques in Modern Geography) No. 38 (London: Study Group in Quantitative Methods, Institute of British Geographers, 1983).

¹⁰ Lancaster and Bodenhamer, "Electronic Cultural Atlas Initiative," 168-69.

¹¹ See, for example, Donald A. DeBats and Mark Lethbridge, "GIS and the City: Nineteenth-Century Residential Patterns," in Knowles, ed., *Emerging Trends*, 78-98.