November 7, 2012
Noreen Whysel
LIS 651 Information Professions
Assignment 3: Trend/Research Paper

Archiving Digital Maps

Introduction

I have been a member of the Geographic Information System ("GIS") community in New York City, since the early 1990s when I was a real estate researcher at Price Waterhouse. In those days, except for certain Federal departments, like the US Census, geographic data was largely held by the institutions that created it. Datasets were static, finite and, until the advent of DVDs and the World Wide Web, difficult to share, due to their often massive file size and the slow speed of internet file transfer. The sharing that did happen was informal, occasional, and often blocked, inadvertently or deliberately, by agency policy or licensing terms that restrict third party distribution. Census data and commercial products, such as demographics tables from *Sales & Marketing Magazine*, were available at the New York Public Library on tape, microfilm and later on DVD, but more proprietary data sources were often obtained through expensive licensing agreements or barter and a network of "who you know." The GIS user group, GISMO, (GISMO, n.d.) formed in 1990, was one place where such sharing occurred.

GISMO was originally created as a software user network where GIS professionals shared information on GIS tools and applications and presented projects at informal bi-monthly meetings. At the time that GISMO was formed, NYC agency geographers were frustrated with the lack of centrality of geographic data at the City level. There was no common base map of New York City on which to overlay geospatial data and no City library where geospatial resources were archived and available for extensive employee use. To address this problem, GISMO offered the following data advocacy statement:

> GISMO supports freer access to data through interaction between NYC area GIS users as well as the following long range initiatives:
>
> - Developing common electronic base maps for GIS users in NYC.
> - Facilitating the data distribution among city agencies and between the public and private sector.
> - Coordinating local information systems for synergy, economy, and accuracy.
> - Providing GIS resources to technologically isolated organizations.

In this paper, I will take a look at the access issues that led a group of geographers to work toward developing a centralized data repository for New York City and how these efforts were mirrored and extended at the national level. While I learned a lot about GIS metadata and software, I will focus more on policy issues around the management of geographic data collections and then discuss archiving management issues more generally. I will avoid delving deeply into political themes around data access and control, though they do have a role in the history of geographic data and how public release and archival decisions are made. I will present information on early data clearinghouses and website archives which provided examples for more robust archival programs at local and national institutions, including NYPL, the Library of Congress, Data.Gov and the NYC Open Data initiative. I will also look at the cost of data, economic limitations on access and the promise of open data.

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What is Geographic Data?

Ask most people what geographic data is and they will most likely describe it in terms of a map. Older users may describe the Rand & McNally road maps they used on family vacations. Younger users may be more familiar with Google Maps or the maps included in online listing services like Yelp or TripAdvisor. It is certainly true that maps are the most recognizable representations of geographic data, but not all geographic materials are maps. Geographic data may be as small as a single x/y coordinate, specifying a location and can be as large as the U.S. Census' Statistical Abstract or a cell phone carrier's database of sensor information about the location of every one of its subscribers. How many people really know the size and format of data behind the store locator map on their favorite retail website?

Geographic information can contain the coordinates for a specific points or boundaries on a digital representation of a geographic space. In addition, any number of datasets can be layered over the physical data to describe everything from community population patterns, building lots and footprints to the migratory patterns of birds and projected spread of California wildfires. The data behind the map can be a fixed set of statistics to dynamic, real time data collected by sensors. Or it can be the paper and ink of the Weather page in your local newspaper.

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Who Uses Geospatial Data?

People have been using geographic data for centuries in the form of maps, censuses, surveys, public property records and many other records. One of the oldest such records is the *Domesday Book* (Figure 1), a survey of private land in England and Wales that was created in 1086 C.E. The data collected in this survey much like the kind of data available in today's property tax records, such as landholder name, dimensions, transfer date, value, tax assessment, economic use, as well as additional data such as amount of arable land, location of streams and rivers, forests and other environmental features (Domesday Book, n.d.).

Figure 1: The *Domesday Book*
(image source: http://www.nationalarchives.gov.uk)

But unlike the *Domesday Book*, much of today's geographic information is born digital. As Adam Farquhar, of the British Library said, "…the world has in some ways a better record of the beginning of the 20th century than of the beginning of the 21st" ("Born digital," October 21, 2010) Today's software, from camera phones to GIS, produces original documents that are born digital. The data used to create the document often exists in databases on the computer, on the internet or otherwise behind the screen. With advances in internet technology over the past decade, the software output for born-digital documents is very easy to share electronically. The knowledge output – the Information – is preserved in the saved file, such as databases, PDF or image file. In fact, many of the maps, infographics and photographs in today's publications have never been produced on paper, nor are they intended to be.

Today, the Library of Congress Geography and Map Division holds the world's largest cartographic collection, with 5.5 million maps, 80,000 atlases, 500 globes and globe gores, 3,000 raised relief images and 20,000 digital files. Their focus has been in scanning historical maps, such as the 1995 American Memory Project which covers the Revolutionary War, the Civil War, U.S. city maps and railroads, with the addition of international maps after 1999. So far, more than 24,000 cartographic objects have been scanned and are available on the Library of Congress' American Memory Website.

Compared to the output of today's GIS community, 24,000 digital files is quite small. Also, not all items in the Library of Congress' digital collection are geo-referenced. This is changing. According to John Herbert, who presented at the LOC's GeoSummit 2009 conference, "Traditionally, the Geography and Map Division has acquired the completed map. Today, the need to acquire the layers of data from which a map can be made takes increasing priority" (Herbert, 2009).

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How is Geographic Data Classified?

With the advent of geographic databases and GIS, there has been some confusion about whether to classify certain geographic materials under The Anglo-American Cataloging Rules ("AACR2") Chapter 3-Geographic Materials or Chapter 9-Electronic Resources. In 1998, the Library of Congress developed guidelines for distinguishing these materials (Library of Congress, 2002). These guidelines refer to Leader/06 values "e" (Cartographic material) and "m" (Computer file) of the MARC 21 Bibliographic Format.

Cartographic Material Definitions

AACR2 definition:

> Cartographic material. Any material representing the whole or part of the earth or any celestial body at any scale. Cartographic materials include two- and three-dimensional maps and plans (including maps of imaginary places); aeronautical, navigational, and celestial charts; atlases; globes; block diagrams; sections; aerial photographs with a cartographic purpose; bird's-eye views (map views), etc.

MARC 21 definition:

> e - Cartographic material
> Code e indicates that the content of the record is for non-manuscript cartographic material or a microform of non-manuscript cartographic material. This code is used for maps, atlases, globes, digital maps, and other cartographic items.
>
> m - Computer file
> Code m indicates that the content of the record is for the following classes of electronic resources: computer software (including programs, games, fonts), numeric data, computer-oriented multimedia, online systems or services. For these classes of materials, if there is a significant aspect that causes it to fall into another Leader/06 category, code for that significant aspect (e.g., vector data that is cartographic is not coded as numeric but as cartographic). Other classes of electronic resources are coded for their most significant aspect (e.g., language material, graphic, cartographic material, sound, music, moving image). In case of doubt or in cases where the most significant aspect cannot be determined, consider the item a computer file.

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According to the Guidelines, use “e” (cartographic materials) for the following types of materials:

- Images of cartographic material, whether scanned or constructed from digital files with file formats such as: GIFs, TIFFs, BMPs, JPEGs, etc. Treat images of geographic features as cartographic when they are combined with spatial or geo-referencing tools (such as the geographic coordinates longitude and latitude, or grids).
- Data, primarily vector data, that produce cartographic images when processed by software products such as geographic information systems (GIS)
- Atlases, including multimedia atlases whose significant aspect is cartographic, even those that may include large quantities of textual or alphanumeric data. Multimedia atlases often include non-cartographic data that facilitate a spatial understanding of things, concepts, conditions, processes, or events in the human world.

Use “m” (Electronic materials) for the following types of materials:

- Computer games, even those that may have cartographic or geographic content
- Application software used to create, manipulate, or edit maps, and utilities used for viewing maps
- Geographic Information Systems, database management systems used for the capture, storage, retrieval, analysis, and display of spatial data

- Multimedia works for which the significant aspect is not cartographic (or there is no significant aspect)
- Primarily textual materials (currently coded "m" but will be coded "a" (language material) in the future after the implementation of MARBI Proposal No. 97-3R)
- Databases with a subject/topical focus that also have a geographic interface to the data

Why Save Geospatial Data?

Historians use GIS data for research and teaching. According to *ArcNews Online*, "Historians are noticing GIS because they normally deal with processes in complex, dynamic, nonlinear systems and, therefore, demand a means to organize a large number of variables…." (Owens, 2007). Economists also like the ability of GIS to present clear visualizations in a familiar way. Notable information architect, Richard Saul Wurman, and information scientist, Edward Tufte, are both proponent of maps that present information in a way that Wurman has said helps to "make the complex clear" (Wurman, 1997). GIS adds the ability to view data layered dynamically, over time.

In government, geographic data is collected for transit, housing, economic development, emergency management, tax assessment, utilities management, public health and pretty much any civic use you can think of. GIS data includes everything from the base map, which can vary in detail, projection, etc, to demographic data, physical data (like contours, elevation, building footprints), boundary data (like school, zoning and political districts), streets and roads data, and the location of public institutions. It can tell policy makers how changes in demographics are affecting transit capacity, whether trends in commercial and industrial activity in a particular neighborhood justify a zoning change, and which critical infrastructures may be affected in an emergency. Particularly in emergencies, swift access to data offers a broad operational picture and the ground details that are necessary to control and respond to situations that are a threat to life and property.

If you have a smart phone with GPS capability, you are producing an enormous wealth of geographic data that may be accessible and used by your carrier. You can choose whether or not to allow that data to be accessed by applications on your phone, but your carrier holds on to that data, producing an ever growing abundance of information on any of its system users. Aggregate customer data has value as it can, for example, give an indication of the range in which its customers roam, justifying pricing for various features of the calling plan.

Geolibraries

In New York City, GISMO developed a partnership with the Map Division at the New York Public Library, which archived their newsletters until 1996, when the newsletter went online and ceased to be produced in paper form. These early newsletters document the needs and wishes of the GIS community in the New York City area for freer and more open access to data produced by government agencies. They also document the efforts at coordinating and managing data collections in the early years before high speed broadband networks, "Big Data," GPS enabled devices and handheld map applications existed. This partnership is an example of a geolibrary as a "geospatial one-stop," as described by Michael Goodchrist (1998).

Geolibraries are not just map libraries. As noted by J. Boxall, in describing Goodchrist's work (Boxall, 2003), they are places that provide access not just to geographic information but also to "…georeferenced information …including such things as photographs, videos, music and literature that can be given a locational variable that defines a footprint." Boxall states that geolibraries bridge the fields of library science, geographical information systems and cognitive science/HCI, providing geospatial information access and management.

Concepts in GIS and Library Science

GIS	Library Science
Metadata	Cataloguing
Information management	Collection
Common to Both: access, sharing and preservation	

Recognizing the common ground between the GIS/cartography and the library science communities has led to a number of preservation models described in the next section.

Geospatial Preservation Models

One of the first public data collections in the New York region was the NYSGIS Clearinghouse, which was founded in 1997 by the NYS GIS Data Sharing Cooperative, "a group of governmental entities and not-for-profit organizations that have executed Data Sharing Agreements for the purpose of improving access to GIS data among members" (NYS GIS Clearninghouse, n.d.)

Data Sharing Cooperative

The Data Sharing Cooperative was primarily developed to encourage public agencies in New York to share in the creation, use, and maintenance of GIS data sets at the least possible cost. Two key features of the Data Sharing Cooperative are:

- Data creators (primary custodians) retain ownership of their GIS data sets, but agree to share it with other Cooperative members for free or, at most, for the cost of copying it; and
- Users of the GIS data (secondary custodians) pass updates, corrections, and revisions back to the creators of the data set, resulting in improved data quality.

The NYSGIS Clearinghouse was a model of collaboration for entities sharing geographic data (Eglene & Dawes, 1998). Contributors who sign the Data Sharing Agreement designate a GIS employee as contact and provide an inventory of datasets to the clearinghouse. Members are required to create metadata describing their GIS datasets for inclusion in the NYSGIS Clearinghouse's Metadata Repository.

Still, contributions to the NYSGIS Clearinghouse remained voluntary and often restricted by licensing agreements and agency policy. Managers were skeptical of a forum where data, which costs money to produce, is freely posted and freely used by commercial entities that might repackage and sell back to agencies. Calls to change New York State's Freedom of Information Law to allow agencies to charge a fee for certain datasets were met with opposition from industry. Agency managers also feared there would be hidden costs or risks to providing data to the public. The cost to the Clearinghouse itself was minimal, and included the salaries of two full time staff people, 50% of a Project Director and one other staff person's time and the computers, software and hosting account required to keep the clearinghouse online.

Geographic data is a key component of the National Digital Information Infrastructure and Preservation Program (NDIIPP) of the Library of Congress, which was authorized by Congress in December 2000, with the goal of building a nationwide network of partners working to build a preservation architecture (North Carolina Geospatial Data Archiving Project, 2000). In April 2008, Steve Morris, Head of the Digital Library Initiative at North Carolina State University (NCSU), gave a tutorial to LOC staff on geospatial data. NCSU's North Carolina Geospatial Data Archiving Project (NCGDAP) is a collaboration between the NCSU Libraries and the North Carolina Center for Geographic Information and Analysis. The project focuses on collection and preservation of digital geospatial data resources from state and local government agencies in North Carolina and serves as a demonstration project for other states (Library of Congress, 2008).

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North Carolina Geospatial Data Archiving Project

The objectives of the North Carolina Geospatial Data Archiving Project (NCGDAP) are:

- Identification of resources
- Acquisition of at-risk geospatial data
- Development of a digital repository architecture for geospatial data, using open source software tools
- Enhancement of existing geospatial metadata with additional preservation metadata, using Metadata Encoding and Transmission Standard (METS) records as wrappers
- Investigation of automated identification and capture of data resources using emerging OGC specifications for client interaction with data on remote servers
- Development of a model for data archiving and time series development.

In 2007, the NDIIPP worked with state government archives and GIS practitioners from Kentucky, North Carolina, and Utah to create the Geospatial Multistate Archive and Preservation Partnership (GeoMAPP). Incorporating lessons learned from NCGDAP and the Open Geospatial Consortium, a national geospatial organization, the final report released by GeoMAPP included the following key findings, which can serve as a preservation and archiving model for local and state geolibraries.

GeoMAPP Key Findings

1. **Establish a geoarchiving team** with participation from the GIS, archives and IT communities to work with data producers, cross train and tackle the geoarchiving challenge.
2. **Inventory GIS holdings** and document information such as data ownership, theme, age, frequency of update, format and size about data to be considered for preservation.
3. **Appraise**-Develop a formal policy to assess which datasets need to be preserved based on legal, historical, business, and research value.
4. **Data Prep, Transfer and Ingest**- Develop standards for metadata, file formats, file naming and data packaging, and create attainable processes to prepare, transfer, review and ingest geospatial data into a robust archive for long-term preservation
5. **Preserve**- Store multiple copies of archived data on diverse storage systems that track the location and integrity of each file
6. **Provide Access** to your archived holdings to allow the public to take advantage of these resources, to add their own value to the data and to become supports of the geoarchiving process
7. **Justify the Investment** through the development of metrics for measuring costs and benefits derived from specific use cases and the preservation process. Develop a programmatic strategy to track and document benefits over time to demonstrate success.

In the commercial sector, GIS software giant, ESRI, has created a GIS map portal called *ArcGIS Explorer Online* (ESRI, n.d.). This website allows users to access an online version of ESRI's ArcGIS software via Microsoft Silverlight, where they can produce and share maps online. Users can access data from publicly shared maps or import their own datasets. Users can also select a variety of basemap styles or import their own. They can also create private groups to share within a smaller community of users.

New Models of Preservation and Sharing

The September 11, 2001 attack on the World Trade Center presented an imperative for developing shared geospatial data systems. While New York State and the

Library of Congress were experimenting with initiatives for sharing and archiving digital geospatial data, New York City's data was still largely siloed within agencies. Some of the problem was related to infrastructure. In 2000, there were difficulties with bandwidth, storage and the interoperability of data formats that made sharing less seamless than it is today.

On the day of the attacks, the NYC Office of Emergency Management was located at 7 World Trade Center. The facility had generators, backup generators, a water supply, and a ventilation system, computer hardware, telephones, and radios with uninterruptible power supplies. It also held GIS software and data about City facilities such as schools, hospitals, and nursing homes, information for mapping flood zones, evacuation routes, emergency transportation routes, and shelter locations. Then the building had to be evacuated. The only backup system was located in a building near Ground Zero, which also had to be evacuated (McConnell, November 7, 2011).

September 11 became a catalyst for cooperation and public engagement. With the collapse of 7 World Trade Center, the NYC Office of Emergency Management lost access to its geodata repositories. The City engaged volunteer responders, citizen geographers, businesses, response teams from all over the world came to help at a makeshift Emergency Operations Center on Pier 92. Many of the volunteers were GISMO members, who understood the gaps in the information flows and knew who in their network had the data or systems that were needed to fill the gaps. The imperative to improve data flow at least between agencies was clear, and increasingly, so was the understanding that the data and the maps and other geographic artifacts that were being produced had precious and significant historic value.

New York City Mayor Michael Bloomberg passed an Open Data Mandate on March 7, 2012, requiring all city agencies to make their data available to the public.

New York City Open Data Mandate, March 7, 2012

1. The Department of Information Technology & Telecommunications must post on its website a technical standards manual, which will help agencies make their public data available to the greatest number of users and for the greatest number of applications.

2. Within a year, each agency must convert all of its public data sets that are currently online in "locked" formats into formats that enable computer programmers to use the data to build applications.

3. Within 18 months, the Department of Information Technology and Telecommunications will work with each agency to post a compliance plan, describing all of the public data sets in each agency's possession. The plan will be then be updated each year, and will serve as a roadmap for agencies to post these datasets to a single Web portal by 2018 (Hanson, March 12, 2012).

The availability of open, accessible municipal data, coupled with the real-time, Big Data of smart phones and sensor devices has allowed the development of a multitude of products for simplifying everyday life and civic response. We use our smart phones to look up the quickest transportation routes, a good cup of coffee or to find which of our friends are nearby and can grab a coffee with us. It also opens the data for use by city agencies in common, interoperable formats, realizing many of the goals of data access set forth by GISMO two decades ago.

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Management Issues

Understanding the history of data preservation models we can now look to the future of geolibrary management. The following sections offer brief thoughts on management issues that geo-librarians can expect to face with regard to geographic materials, including accuracy, access, and cost.

<u>Accuracy</u>

One role of a geolibrary would be to educate users on how to use geographic systems to describe real world problems. As with any reference question, a focus on authority and accuracy of the data is of great importance. In an interview on WNYC Radio (Zomorodi, November 20, 2012), Steve Romalewski of the Center for Urban Research at City University of New York described how maps can be created to show change in patterns over time. The CUNY Mapping Center applies data and imagery layers over a base map and has also utilized sliders that allow users to view Census changes directly in the map. More recently the US Geological Survey and the Federal Emergency Management Agency has used mapping imagery to view changing coastlines and plot addresses at areas that experienced severe damage. In future years, historians will find a wealth of understanding of how natural and human events impact the physical geography of disaster.

Mr. Romalewsky is careful to note that flaws in methodology occur frequently in map visualizations, citing as an example WNYC's stop and frisk map, which shows an inverse relationship between stop and frisks and gun recovery that is not supported by the data. His remapping of the data showed that the most gun recoveries occurred outside the stop and frisk hotspots (Romalewsky, July 27, 2012). Digital map features from projection to color scheme and the number of data sets overlaid on a single view can help or confuse the user. CUNY's own overlay interface for "Visualizing a Changing Region, Block by Block" (CUNY Mapping Service, 2011), which shows demographic changes from the 2000 to 2010 Census, suffers from a data morphing feature that allows intervening years to appear to change at the same rate. The center position between 2000 and 2010 isn't necessarily what 2005 looked like.

The CUNY map does contain detailed information on how to read it, what the features do and what the data describes. Digital maps that include these details allow users to better understand what the map says and does not say.

Access

One of the most basic levels of access is data format - Does it work with your system? Is the data in a standard format, or will it need to be converted for interoperability? Some of the digital map standards include XML, RDF, and domain specific formats such as Keyhole Markup Language, or KML, a file format used to display geographic data in an Earth browser such as Google Earth, Google Maps, and Google Maps for mobile and Common Alerting Protocol or CAP, which is an an XML-based data format for exchanging public warnings and emergencies between alerting technologies.

A second concern for data access is language. What definitions are you using to describe the problem and the tools you are using to solve them? Make sure the vocabulary used by the data source matches up with your understanding and use.

Acronyms can be confusing. For example, the Department of Homeland Security and the New York City's Department of Homeless Services, use the same acronym (DHS) The Federal Emergency Management Agency's National Information Management System (NIMS) accounts for overlapping definitions. Also in raw data output, column headers are often coded. Make sure you are using the right definition, or create a joined table that maps the header in one source to the corresponding data in another.

Commercial licensing can restrict sharing of data and information between parties, sometimes including the output produced by a given system. Are there restrictions on how the data can be used or whether it can be shared? Is the license based on a per-seat model, or can anyone in your organization download and use the software? Can the licensing agreement be negotiated to allow access by certain third parties?

Cost

Variability in cost can be considerable, not just in decisions for which systems to support and how many people are expected to use them, the kind of training required, who will support the materials (both technology and reference support) and the number of geographic datasets, journals and related materials to preserve in your collection. If your library is planning to provide public use and training on GIS tools, for example, appropriate licensing will need to be negotiated with the vendor. These fees can be very high. A single-seat site license for ESRI's ArcView GIS is under $2000, but institutional use, specialized databases and implementation support can overwhelm the budget of a small library. Open source GIS programs and open Application Programming Interfaces

(APIs) like Google Maps are available, but come with their own training, maintenance and licensing/copyright issues.

The demand for affordable solutions is encouraging corporations to develop products that can be accessed by small government bodies, organizations and individual users. Google now offers a freely downloadable bundle of emergency management tools in its Google Crisis Maps product (Google, n.d.). ESRI released an online version of its software, called ArcView Explorer (ESRI, n.d.), and recently released its software as a plug-in for the ubiquitous Microsoft Office products. Communities like GISMO are great places to find experts willing to extend a helping hand in sorting through options and finding data resources.

Conclusion

While it is encouraging that a committed group of advocates from the geospatial community set the stage for development of geolibrary policy at the national level, geolibraries are not just for government policy makers. The recognition that freer access to geographic materials can make life easier for ordinary citizens, as well as government workers, has opened up public interest in maps and map-making, increasing the variety of and demand for geographic resources and training. The role of the geolibrary as a repository for these materials and a place for training in both public, private and government settings can be expected to grow with the demand from a wide population of users. New tools, open source data and a wide, sharing community of users are resources for an exciting world of geographic possibilities.

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