ANALYSIS OF SPATIAL INFORMATION TO IMPROVE RETRIEVAL OF CARTOGRAPHIC MATERIALS BY PROVIDING GEOGRAPHIC COORDINATE INFORMATION

By

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To my family, all graduate students of Geography past and present and all sentient beings everywhere

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LIST OF ACRONYMS

AACR2	Anglo-American Cataloguing Rules (2nd Revision)
ADEPT	Alexandria Digital Earth Prototype project
ADL	Alexandria Digital Library
ALA	American Library Association
ACLTS	Association for Library Collections and Technical Services
ACRL	Associations of College and Research Libraries (division of ALA)
BGN	U.S. Board of Geographic Names
ESRI	Environmental Systems Research Institute
FGDC	United States Federal Geographic Data Committee
FGDL	Florida Geographic Data Library
GIS	Geographic Information Systems
GNS	GEOnet Names Server
GNIS	Geographic Names Information System
HUL	Harvard University Library
JSC –	Joint Steering Committee for revision of AACR
ICPFDA	International Conference on the Principles and Future Development of AACR
MAGERT	Map & Geography Round Table (ALA)
MARC	Machine Readable Cataloging
NRC	National Research Council
OCLC	Online Computer Library Center
RDA	Resource Description and Access
USGS	United States Geological Survey
USPS	United States Postal Service

Abstract of Thesis Presented to the Graduate School
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This work presents research findings on how geographic coordinates can improve the retrieval of library materials at the University of Florida Libraries while attempting to provide spatial information to library bibliographic records for more efficient access of cartographic materials. Retrieval and accuracy problems arise because maps are not always published with coordinates. The researcher can follow library cataloging rules in order to provide coordinates on bibliographic records, and interpolate numbers by following strict guideline standards. Bounding boxes and center point coordinates are key components in the library catalog record. Additionally, GIS has universal applications that apply to interdisciplinary studies and international cooperation in regard to establishing standards.

The objective proposed in this work is to see how spatial information through the use of geographic coordinates can help not only to read and manipulate cartographic data but also to help organize other library materials. By improving library classification schemes of electronic and digitized materials and also enhancing traditional classification and retrieval mechanisms and standards, University of Florida Libraries' catalogers can keep up with the researchers' demands for better access to materials. The UF Libraries can then attempt to shift to newly

created and shared geographic information systems and use spatial data that allow for the retrieval processes to increase usage, access, and metadata integration.

This work explores the importance of understanding and applying map cataloging rules to provide the most accurate information possible in the local database. It offers additional methods to help find maps and other cartographic information quickly and accurately from an online retrieval database. A strong need has occurred to standardize spatial data to improve search query responses by providing uniform information and by addressing thematic errors. The work will present the idea of using the digital library to help introduce the concept of spatial reference to enhance retrieval capabilities, teaching, and learning.

CHAPTER 1
INTRODUCTION*

The main objective of this work is to examine the use of geographic coordinate information to improve the retrieval and indexing of cartographic materials. The work will touch upon how the existence of print material libraries--as highly organized information warehouses--is essential, and how they can help in the organization and presentation of digital and online libraries. This work will also show how digital libraries can benefit from the established and uniform way that information is made available (Rauber & Tjoa, 2000). Libraries and their online catalogs must also compete with search engines and full-text retrieval capabilities that are taking place on the World Wide Web.

With the need for increasing international collaboration in the delivery of research materials, library cataloging practices need to be considered to facilitate shared online resources. Academic and research geographers and librarians must tap into a new technology and impose a new cultural approach to creating methods suitable for making information retrieval easier.

In order to make good decisions to improve a library database, it is necessary to understand the process involved in cataloging cartographic information. Current cataloging mechanisms are not adequate in describing the material in hand due to not putting into practice rules for providing adequate information. New information retrieval tools are being used to facilitate the retrieval of information (McEathron, 2002, p. 181). This work will examine how these can be integrated into current techniques to improve the process of indexing and retrieving geographic information.

* A significant portion of this thesis appears by permission from Gonzalez, Jorge, (2007) from "Problems that arise when providing geographic coordinate information for cataloged maps," *Coordinates: Online Journal of the Map and Geography Round Table, American Library Association*, ser.B, no.8.

Publications of a cartographic nature include: atlases, maps, census documents, aerial photographs, and satellite images. Geographic information system (GIS) is a system designed to allow users to collect, manage and analyze spatially referenced information. It is critical to understand economic development and have an increased awareness and knowledge of geopolitics. It is a way of capturing, storing, analyzing and managing data which are spatially referenced to the earth. It is necessary to use GIS to improve our understanding of natural resources and the environment. Modern technology allows improved acquisition, distribution, and utilization of geographic and cartographic data. An effort is underway to create an infrastructure at different levels of government and private sectors to support applications of spatial data in areas of transportation, agriculture, emergency response, environmental management, and information technology, museum development and maintenance, and other research related fields (Onsrud, 1995).

New technology has made the process of information research available through digitization, which has benefited many disciplines. Without appropriate geographic elements, bibliographic information will remain dispersed and inaccessible, and also dependent on inexact description executed by untrained catalogers (Lai & Gillies, 1991).

Place names are readily defined by librarians through geographic subject headings, and they are a way of describing location for library materials. They are useful for identifying spatial information as locational or place name headings in text form (Woodruff & Plaunt, 1999). As technology via the Internet has brought the world to our doorstep, people have become increasingly more aware of what is out there, but usually needing to find out where exactly out there is. Human activity of every nature requires space and exactitude, location becomes critical

information. This work will therefore focus on the benefits and uses of providing geographic coordinates to library bibliographic records of a cartographic nature.

The basic information discussed will concentrate on providing geographic coordinates to library map records. Libraries seek to organize everything, including the geographic nature of materials, in a way where a researcher will find explicit location classification central to his queries. Indexing and searching, and--for the researcher--finding are fundamental operations in making retrieval of materials more efficient. The cataloging goal in libraries, including cartographic materials, is for the cataloger to prepare the material in hand for its most accurate accessibility by indexing each document from established nationally and internationally recognized standards.

Searching for cartographic materials, as with other library materials, may be done directly by examining shelved items or by searching vicariously via databases in the online catalog. Cataloging is the most fundamental operation of indexing library materials (Dillon & Jul, 1996). This action recognizes groups of classes of objects, as in cartographic materials, via map cabinet or shelf placement order and the classification schema. Library classification will help the researcher use a number of different devices--enhanced with geographic coordinates--for retrieving materials from the physical collection or from digitized information.

This work will demonstrate a need to react to the changes occurring in information technology by looking at the way libraries, and cataloging methods specifically, are using spatial referencing to enhance or improve library research. This work will offer a systematic approach to providing coordinate information based on established guidelines followed by discussing the issues involved in providing them.

CHAPTER 2
LITERATURE REVIEW

Geographic Information Systems (GIS) may represent a new way of looking at information (to librarians, not necessarily geographers). Such systems integrate computer hardware, software, data, and the human mind to bring new perspectives to problem-solving. To solve spatial-related problems, it is necessary to have georeferenced information or data that can be layered with more data. As an emerging technology for libraries, GIS raises a host of issues: cost, a steep learning curve, and a lot of computer space. At the same time, it is an attractive technology that most proponents claim has revolutionized the way people look at the world and the way to solve the issues of switching from print to digitization technology.

Writings about geolibraries and access to information, archiving, and collection development, have tended to over simplify-library issues or focus too much on the computational aspects of libraries. It is assumed that GIS users regard metadata standards and processes related to information description as new or unique, or even highly technical (Boxall, 2002).

In regard to geolibraries: geography and spatial information are the catalyst for this new virtual information repository. But maybe this is the new archetype for the "old" fields of geography and library science? Geography and library science are natural partners in this new development. Technology, chiefly digitized information on the Internet, is the primary operator in the need for libraries to adapt to this new-found home for GIS and spatial information. The geolibrary, as defined by Michael Goodchild (1998, quoted in Boxall, 2003, p. 20), is one "filled with georeferenced information" and based upon the notion that information may have a geographic "footprint." While geographers worked with geographic information, the idea now is being able to work or contribute to georeferenced information, such as photographs, videos, music, and literature--all providing a locational variable and needing a locational search.

Geolibraries have both geographic and digital information, while digitization is the direction that information is headed since the spatial information being produced needs geographers to organize and access it. The fast movement in technology in regard to spatial-data infrastructure has brought libraries and geography together like two fast trains about to crash into each other. This technology has put many ad hoc groups racing to come up with a common language for new common goals.

With the rapid developments in the digitization of maps and other library print materials and also the creation of Internet networks and databases, access to geographical information is increasing at a surprising rate. The technological environment has developed so that it can facilitate seemingly complicated spatial operations. Digitized maps and spatial data from other digitized materials have been coded to provide information for general purposes. This basic use allows the use of the Internet for easily downloaded information from around the world, and it is not unusual for researchers and other Web users to acquire real-time observational data.

One fact stands out among the discussed pros and cons: geographic referencing is here to stay and has become a fixture in 21st century libraries just as automated catalogs and multimedia collections have been available for quite a while. New ways need to be used to index the information that technology has made available to researchers--but not without the benefits of traditional skills of librarianship. The library professional must evaluate user needs, select data, prepare and catalog data for users, and design, serve, and manage public services. In fact, if there is anything significant that librarians have discovered about georeferencing their materials, it is that they cannot do it alone. More than any other service, spatial information and GIS are perfect opportunities for libraries to partner with outside entities, specifically geographers.

The creation of print databases, as digitized materials, and the metadata to accompany the materials, while applying GIS to create databases, have shifted from what was a static geography of book production to an active spatial form of information. Geographic concepts have taken the forefront due to the ability of GIS to provide attention to different academic fields by layering information that contributes to the broader understanding of what is communicated. Conversely GIS addresses the needs of specific studies, such as demography, economic history, and social history. Geographic Information Systems would provide a link to disparate sources and allow comparison and close examination of various print materials.

Map classification is a process that involves an orderly and systematic assignment of each item to one and only one class number within a system of mutually exclusive and non-overlapping classes (e.g., where G4410 will be assigned to Mexico or G8200 to Africa and up and down the geographically related range). This process must be systematic and orderly: systematic because it mandates consistent application of these principles within a framework of a prescribed ordering of reality, and orderly because it carries out an established set of principles that govern the structure of established classes. While a scheme itself can be established by anyone, purpose and meaningful organization must be considered. Also to be taken into account a history and tradition of materials indexed under the system with room for amending and improving as the need arises that librarians most likely are qualified to provide (Smith & Sproles, 2004, p. 23).

Maps are defined mainly by using bounding-box coordinates and point locations within a radius of a point, in addition to administrative subdivision, or locality description, using, when necessary, a standard thesaurus such as the Library of Congress Subject Headings (LCSH). This

indexing will not restrict researchers to just digitized databases but also to the improvement of analog materials or the physical library (Smits, 2000, p. 509).

Geographic headings consist of two types: jurisdictional and non-jurisdictional. Jurisdictional headings are most commonly used as corporate body entries. These entries are names of groups or governments associated as an entity on bibliographic records, making them capable of being identified as author of a material cataloged while they can also be used as subject headings. These subjects are established according to the rules in AACR2, Chapter 23. Traditionally, names of countries and administrative divisions within countries, such as provinces, states, counties, and cities, take on a jurisdictional heading entry (HUL, 2006), (e.g., eventually being able to group countries as East and West Germany into one group: Germany).

Geographical information is found in many forms whether visual (maps, aerial photos, and remote sensing images) or textual (surveys, reports, technical papers). Although geographic information has been indexed spatially through GIS, reports and other text materials have relied for decades on the indexing of library catalog methods. As libraries continue to digitize more visual and textual information, a greater need has arisen to complement this information with spatially referenced headings. Geography must be viewed as information space for the simple reason that digitized information is seen as spatial (Cai, 2001).

According to Larsgaard (1996), “With very few exceptions, every reference question for planetospatial data starts out with location, (p.28).” So, it has quickly been determined that bounding coordinates are essential. For spatial data in digital form, this information is often in the header or derivable from inside the digital data. For aerial photographs, deriving spatial information is a nightmare because you have no geographic references come into play. Software

is needed that determines these coordinates, and GIS and image processing software may have the needed answers.

Because library science has developed under the strictest standards and research rules, and has been able to integrate, albeit at a slower pace than demanded by the public, the spatial analysis needed for geographical searches of library materials. The open systems architecture, application programming, the capability to support integration with other software, and computer languages and geographic coordinates that GIS supplies have all enabled specific and demanding application development to go with the greater demand placed on librarians to provide information.

An essential component of indexing cartographic digitized materials is the processing functions. What needs to be addressed is how geography as a field will play a role in not only providing geographic data but how GIS technologies fit the model of digital libraries, According to Jue (1996),

> Part of the problem with the introduction of GIS into a public library setting is that there has been little research on ways to make accessing and use of digital spatial data easier for the casual data users, a category in which most public library users fall (p.210).

Specifically, since location is a dynamic and effective way to organize information, geographic coordinates can be used to interface all cartographic information and digitization processing in regard to spatial data. Coordinates can help search for geographic information by way of a graphic interface and text searching of physical locations, and may provide for hard copy output results from its queried data.

The development of cartographic cataloging schemes needs could benefit from a base in geography. A spatial component is necessary to classify cartographic materials. Adequate research is also needed to determine if some methods of locating spatial resources are better than

others. From what has been experienced at libraries, it appears that it may be a long time before the most appropriate solutions can be found. Maps are often among the largest and least controlled in a library's collection (Smith & Sproles, 2004, p. 23).

Cataloging has been important in describing traditional library materials. However, traditional library cataloging elements lack certain descriptive information that meets the needs of a new generation of savvy Internet users who are locating spatial resources and demanding search alternatives. Traditional library cataloging is struggling to adapt to the needs of locating resources and establishing standards. However, traditional library cataloging has provided a level of refinement for information retrieval that is highly successful for manual retrieval of bibliographic items.

Map libraries have traditionally relied on place names for geographical searches. Geographic coordinates using latitude and longitude can complement spatially related searches. Using these coordinates will allow for established relationships in relation to information near or between those identified points or lines. Library catalog records are constantly indexed with geographic data that are provided for future use (Buckland, 2007, p. 376).

Providing geographic coordinates to library bibliographic records can be the requirement to improve retrieval of digital spatial data cataloging. This geographic information approach attempts to use the tools of spatial databases and data analysis as a basis for cataloging spatial metadata. This approach is needed because a more complex set of requirements than traditional catalog-based systems would be invaluable to many experienced spatial data users. The trend in this approach is the development of browsers that allow searchers to graphically browse datasets from one or more databases.

University and research libraries will use their digital collections for class work and research. With electronic access, libraries and university programs will share information more effectively with other universities and learned institutions. Geographic cataloging has been important in describing traditional library materials. However, traditional library cataloging elements lack certain descriptive information that meets the needs of a new generation of savvy Internet users who are locating spatial resources and demanding search alternatives. Traditional library cataloging is struggling to adapt to the needs of locating resources and establishing standards (i.e., the term *wetlands* defined by the United States Geological Society (USGS) as a vegetated area that is inundated or saturated by surface or ground water for a significant part of the year). These standards may be identified to other users as: backwaters, bayous, bogs, fens, mangrove swamps, marshes, mires, mud flats, peat lands, salt marshes, sloughs, and swamps. They can include broader terms as biogeographic regions or narrower terms, such as bays, guts, lakes, playas, and streams as found in the Library of Congress Subject Headings (LCSH). However, traditional library cataloging has provided a level of refinement for information retrieval that is highly successful for manual retrieval of bibliographic items.

A geographic approach to providing coordinates and other spatial information is needed because a more complex set of requirements than traditional catalog-based systems would be useful to many experienced spatial data users. The greatest value to this approach will be the ability to interact with catalog-based systems and simultaneously be used over a global network environment. The trend in this approach is the development of browsers that allow searchers to graphically browse datasets from one or more databases.

Geography provides the digital library a locational index for facilitating data retrieval, as allocated by attributes of a georeferenced object. Map and spatial imagery libraries are the perfect candidates for a geographic approach. Most cataloged material can be geographically referenced, such as the information from a collection of museum slides entered into a digital library by location indexing as well as by time period. A collection of butterflies can be photographed and scanned to produce a collection of Lepidoptera information, including color images. All the information of any digitized collection can be accessed by many indexes, including full-text keyword. This collection also includes geographic information such as where the butterflies migrate and how the species get captured.

Georeferencing relates to items in coordinate systems. A familiar system is expressed as degrees of latitude (as in north and south) and degrees of longitude (as in east and west). By using coordinate systems, spatial data from a variety of sources can be compared, organized, and viewed in combination with one another. Latitude and longitude are commonly expressed as decimal degrees, and they are commonly used as a coordinate system for digital library collections.

Geographers who work on geolibraries can become partners, or, better yet, caretakers of the spatial data. They can develop an increase in access, use, and preservation of cartographic and other geo-related materials and digitized information. The two sub-disciplines may have had different paths to their teaching and information gathering approaches, but they have the potential to become a common ally in providing spatial information. Librarians have focused on service; the rest of academia has concentrated on research. Yet libraries will remain in place and continue providing information. While libraries use GIS, their concentration is not on the technology itself. The focus is the people involved in GIS, in this case geographers, who have

assumed that metadata and standard issues are of the technical nature. So these two fields must collaborate to come up with new collaborative ideas or approaches to indexing geographically.

Traditionally, geography has been about gathering information in the field. The spatial process researched by geographers has been acclaimed and used by closely related disciplines. For example, urban geography deals with research and information on spatial processes, such as urbanization and gentrification information that have been used in other academic fields. It is difficult to deny that geography is a fundamental source of research information with a scientific approach, but this comes with an expectation and a responsibility to make explanations and policies regarding spatial processes easily understood. Geography must provide clear answers and a clear direction to tackle these issues.

Geography can address how the collection, organization, presentation, and retrieval of digitized information can be processed while at the same time providing and producing geographic information by means of georeferenced spatial data. Geography curricula can be developed to concentrate on making it easy to find items of interest and how to manipulate the information in as many ways as possible, such as being able to re-compute data and create new maps and datasets. In turn, the digital and physical map library becomes a tool for teaching. Applied research must explore the potential of the software environment and develop tools by designing prototypes.

John Pickles, a distinguished geography professor, attempted to answer how geographic information can help libraries in his paper *Demystifying the Persistent Ambiguity of GIS as 'tool' vs.' science'*. Pickles states that albeit GIS has arrived and lived up to its promises, new technologies continue to enhance what is achievable and accessible to more people (1997,

pp.363-364). The double-edged sword to all of geography's ails is that overnight GIS created a huge demand for technical skills from faculty and staff creating a small hiring pool.

Furthermore, the diffusion and advances of information technology have contributed to a crisis which Pickles identified,

> "The crisis of technological science is also a crisis of liberal legal and political theory. What constitutes appropriate methodology in the social sciences is thoroughly conditioned by the broader representational systems of political belief on which liberalism is founded. This is the Pandora's Box that critical human geographers opened from the 1970s onwards. … [The book] *Demystifying*… calls for the hard work of theory to begin …the necessity of carrying out this hard work through the traditions of thought…and ... calls for a theoretical turn in geography that began in the 1970s." (Pickles, 1997, p. 370)

Jan Smits, noted Dutch cartographer and librarian, and great contributor to the filed of map and geography librarianship,

> The most relevant source of information for researchers in this book is a piece of software called 'Earth', which "keeps track of every bit of spatial information that it owns – all the maps, weather data, architectural plans, and satellite surveillance stuff". When this step is taken further, one may also add to these geospatial data all locational data, which is part of analogue and digital alphanumerical objects and databases, keeping in mind that a lot of spatial phenomena, including human activity, are constantly monitored (2002, p. 22).

Michael F. Goodchild (2004, p. 10), professor of geography at the University of California, Santa Barbara; conducted research related to geographic information science, spatial analysis, the future of the library, and uncertainty in geographic data. Goodchild stated:

> The traditional library has relied on author, title, and subject as the keys to its catalog. Although one might imagine using geographic location as a key, the technical difficulties associated with doing so in a traditional library are profound. But they are comparatively trivial in a digital library, and several WWW sites now support search of their information archives using geographic location as a primary key. One can … search the site of the Environmental Protection Agency … for all information related to a particular area, such as a ZIP code. A geolibrary is defined as a digital library that is searchable by geographic location, returning maps, images, reports, photographs, and even pieces of music identified with a particular location.

CHAPTER 3
METHODS OF ANALYSIS

Approaches Promoting Library Use

This research will demonstrate a need for further proposals and projects in order to evaluate, promote and increase the use of the library, and to advocate the benefits of using professional reference librarians. This research will also make researchers aware of the "limitless" availability of materials accessible to them. Librarians and library paraprofessionals, as with teachers, must see how technology can support standards, facilitate library use, and make learning interesting for students and researchers. Technology must enhance lessons taught in order for the lessons to be effective.

Seven major themes, or approaches, identified as methods to encourage library patrons to visit, participate, and use the library with more frequency. Three of the seven categories (underlined) kept appearing in the course of this research that mostly related to improving access to and retrieval of materials specifically while simultaneously increasing use of the libraries. The seven major themes are:

1. Improved library/bibliographic instruction
2. Surveys/evaluations and user behavior observations
3. Improving virtual access to materials
4. Adjustments to bibliographic content or classification of materials
5. Using non-library, geographic technologies -- Need for human factor
6. Promoting (information) literacy -- Promoting policies that encourage use
7. Reviewing/improving physical barriers/design

Number 3: Improving virtual access to materials: One of the strongest cases is for user awareness and acceptance of digital libraries. A promotion of basic terminology and ease of use navigation must occur. Users must be made to feel less overwhelmed by the increasing number of materials available. Making users aware of the difficulties of logging into a digital environment will also help. Looking into the usability issues and challenges, users will encounter

how librarians can assist. One approach that must be taken is the challenge of making use of map retrieval efficient for the end-user, how education can help this and how library polices must be aligned with those of its parent institution (Roes, 2001).

Libraries can provide information systems that can effectively deliver quality educational materials, which are readily accessible and useful. Digital libraries have been called on to take care of providing search materials. A widely held belief is that digital libraries are the remedy to improve library information retrieval.

Regarding consequences related to the lack of direct human contact, researchers would likely want to see improved ways of retrieving information. Sources would be available right from their desktop. Researchers, as virtual library users accessing online databases, catalogs, and other Internet resources, are becoming more technologically savvy. It may not be beneficial to researchers if they are unable to develop search skills and utilize the knowledge and skills of librarians to help them locate the most appropriate resources. On the other hand, libraries risk being bypassed by this technology and losing relevance to students and faculty if they do not establish their presence in bibliographic instruction. Librarians need to be proactive. Then need to insert links to resources and to library assistance within their classification domain in order to retain visibility, to increase their relevance with researchers, and to show their ability to find appropriate materials (Shank, 2006, Intro.).

Number 4: Adjustments to bibliographic content or classification of materials: This category is essential as a response to users' needs. This category puts together all the tools that can be reviewed and amended in the classification rules and schema that librarians use. Some articles attempt to look at old standards in different ways, even how a library classification system can help with scientific research because of its hierarchical design, thus helping students

find the materials they need. Databases outside the library can be incorporated to complement the library's own databases.

An attempt needs to be made to find a balance between what the users comprehend and the nuances that metadata quality control requires. Another way to look at quality control is to rate the database by how well it can answer questions and not just how well it can retrieve a list of sources. The secret to database improvement appears to be organization. But how can the database be better organized without the input of the users?

As larger quantities of materials are entered into library databases, users are often overwhelmed with information. Increasing the total number of items makes it more difficult to find materials. As hypertext increases, the resolution of searching by way of storing many items increases the complexity of searching. Traditional libraries solve these problems by grouping them together. Electronically, a similar way is needed to organize this increasing amount of information. Highlighting frequent words and phrases and grouping related subject topics can be effective in helping retrieve what the user needs. Counterbalancing the displaying of too many entries using hypertext, the user is left with displaying titles by hierarchical category. The general idea is to apply techniques that solve attempts at detailed queries and get right results the first time (Lesk, 1989, Intro.).

One problem that must be overcome is the perception that online catalogs continue to be difficult to use because their design does not take into account users' searching behavior. A false belief exists that a "search" is independent of further searches assuming that there is no need to formulate different options to explore a topic. Ideally, the approach is that online catalogs will be judged by how well they answer questions and the ease of transferring information to other systems, and not by how well they match queries. For many years it has been argued which

online catalogs are difficult to use because their design does not incorporate sufficient understanding of searching behavior. In the short term, librarians can help make online catalogs easier to use through improved training and documentation that is based on information-seeking behavior, but good training is not a substitute for a good system design. A more permanent goal will be to design intuitive systems that require a minimum of instruction. Given the complexity of the information retrieval problem and the limited capabilities of today's systems, librarians are not close to achieving that goal (Borgman, 1996).

Ideally, an attempt must be made to find a balance that serves a diverse range of library users while making the indexing and management of the database retrievable. The library shall be able to serve outside campus researchers, extension workers, and correspondence studies students. Library professionals need to ask researchers to help in the development of an informed decision-making process that strikes a balance between comprehensibility and metadata standards. Metadata standards are information content for the purpose of providing a common set of terminology and definitions for concepts related to the field of study. Metadata is also data about the content, quality, condition, and other data characteristics. Researchers cannot be overlooked when focusing on the development of a system that tags or indexes metadata to support its use (Shabajee, 2002).

Number 5: Using non-library, geographic technologies -- Need for human factor: Among the least topic written about with the largest scope potential is the impact of the increased availability of information coupled with the advances in information technology retrieval systems, which is the need for librarians to keep pace with the needs of today's users.

Among issues discussed is the need to incorporate geographic coordinate information to metadata, using non-traditional library software that will help knowledgeable, technically

inclined users. At the same time librarians can pass this knowledge on to those technically challenged. Digital advances have created a decline in the use of libraries while increasing the need of real person/real-time help. But libraries will continue their role as research institutions even with the increase in accessing materials via the Internet. The library will need to adjust by not just being an immovable building but a dynamic collection of material able to come to the researcher (Rusbridge, 1998).

Using digital libraries will help in teaching and learning by integrating the use of the digital library and introducing the concept of spatial reference to facilitate retrieval of information for researchers. A goal of the Alexandria Digital Earth Prototype project (ADEPT) is to make primary resources in geography useful for academic instruction in ways that will promote inquiry learning. The ADEPT education and evaluation team found that professors desired the ability to search by concept (erosion, continental drift, and glaciation) as well as geographic location. Resources in spatial digital libraries are typically described by location. Enhancements regarding searching capabilities will include the ability to contribute and to share personal collections of resources and capability to manipulate data and images. Students learn science through inquiries that imitate what scientists practice (Borgman, 2004, p. 179).

Though they are using GIS, few libraries have focused on the technology. New technology must be used effectively but not without the traditional skills of librarianship. The library professional must evaluate user needs, select data, prepare and catalog data for users, and also design, serve, and manage public services. In fact, concerning GIS-based services, librarians have discovered that they cannot do it alone. More than any other service, GIS requires collaboration in the library and partnerships with outside entities, specifically geographers, due to its interdisciplinary approaches.

Many developments in new technology and information sciences have formed the foundation for a growing importance of spatial analysis. This is an exciting frontier that likely will bring significant gains in the technical and theoretical skills and knowledge associated with GI science. In order to accomplish some significant advance, data analysis and computation will continue to be necessary. In addition, these advances are very likely to continue in an interdisciplinary environment where traditional boundaries are brought down. The GIS and library science communities can seize this opportunity and provide the means to develop "spatially integrated" standards.

Outreach

Proposals and can be carried out to evaluate, promote, and increase the use of the library in general and to advocate the benefits of using professional reference librarians. Users become aware of the virtually endless availability of research materials accessible to them. Among the findings from the readings, the research of relevant sources applies mostly to pedagogy, educational and information technology, and other methods to increase library use, this work will note the adage that more access points on a bibliographic record will improve query results for the library user.

The idea discussed is to provide geographic coordinates to all map bibliographic records. This work will present the problems faced with implementing this presumed helpful tool in accomplishing the task of improving search queries. No attempt has been made to claim that providing geographic coordinates to records will reverse the decline of use of libraries in this new digital age. But there is a need to provide extensive information as more people are not using librarians' services (Martell, 2005). It is important to note that library patrons and researchers must learn that the sources exist and that the library has them. The end result is

improving users' access to information whether they take it for granted or appreciate it as much as a librarian.

Researchers need to search for specific locations in a database and to retrieve relevant items based on coordinates provided. The searching and retrieval has to be done efficiently and effectively, even when the scale of the database reaches the astronomical terabyte size. Not only do the items need to be digitized but also indexed appropriately so they can be retrieved (Larson, 1996).

The map librarian have the responsibility of promoting the use of the map library and increasing the value of the collection. Dawn Youngblood, curator at Southern Methodist University, outlined the following recommendations:

- When new cartographic materials arrive, inform members of the appropriate discipline.
- If you have foreign language maps that no one uses, contact professors and students in the language departments and make them aware of their existence and usefulness.
- Give public speaking presentations with maps or PowerPoint presentations with scanned maps at informal talks or brown bags.
- When patrons enter the map collection, ask them if they are aware of the other resources in the collections.
- Offer patrons courses on map making or using GIS to create their own maps (2006, pp 62-63).

Map librarians need to assess their users' needs if they are to find digital solutions to their inquiries, and they need to think "digital" to start identifying the kinds of queries which can work better with electronic technology, as opposed to the traditional and conventional paper map-based solutions. Digitally based electronic cartographic materials have the potential to deliver more efficient information than the map sheet (Parry, 1995).

Besides queries by geographic coordinates, users may be interested in other measured information, such as altitudes, orientation, gradient, distances, scale, distance between points and

land areas. Map librarians must play a bigger interactive role with the users of their map collections. The advancement of digital mapping into the traditional structure of the paper map library gives librarians and users the opportunity to discover and learn the functionality of digital maps. Map librarians will continue the dual role of guides, helping people understand and make sense of graphic images whether digitized or on paper (Parry, 1995).

A shifting of educational requirements must occur for the professional librarians if there is any hope to keep up with the technology needed for them to promote library use. Librarians need to incorporate geographic coordinate representation into metadata for all types of information objects. They need to develop gazetteer services to translate place names in subject headings and coordinates to aid library cataloging to facilitate information retrieval services. Librarians' involvement and active engagement of researchers can help find the balance needed to improve organization of materials.

Exigency in Information Science

This work is an opportunity to point out the problems that libraries face with keeping up with the changes occurring in information science and technology. This opportunity presents a chance to look at the change that may be identified as the crisis part of an incoming paradigm shift. Kuhn (cited in Smits, 2002) used the term *paradigm* to denote a generally accepted set of assumptions and procedures that serve to define both subjects and methods of scientific inquiry:

> When the assumptions and the procedures which serve them cannot answer anymore the aim for which they have been formulated or when the aim seems in need of reformulation as the answers are not adequate anymore, new assumptions and procedures have to be formulated which might answer the questions posed.

Researchers need to be provided access to library resources in a timely and orderly fashion Library collections and library cataloging system must be organized using national bibliographic standards. The catalog or library database provides access for multiple concurrent users and

attempts to indicate all resources available. Provisions are to be made for circulation agreements and access to virtual electronic collections, and also have some way of accessing materials not owned by the library. Policies regarding access will be appropriately disseminated to library users (ACRL, 2006).

Anglo-American Cataloguing Rules (AACR) are designed for use in the construction of library record catalogs. These rules cover the description and access points for all library materials, including those of a cartographic nature. The publication deals with the provision of information describing an item being cataloged, and determining what subject headings or access points will be used as descriptive information on the catalog for the users. Since 1967, AACR has been used by library professionals with highly developed cataloging content standards, or an agreed upon way of processes and procedures. Revisions in the standards since 1978, known as AACR2, clearly define and provide and examples of the cataloging process extending with clearly defined rules and practical examples. These rules and examples represent standards that apply to all types of resources which now include metadata formats (ALA, 1998).

Unfortunately, as information technology has advanced through recent years leaving librarians and information people trying to keep up, more information has also tried to keep pace to help professionals interpret the rules--but with mixed results. Other practical and authoritative cataloging how-to books were published, designed to interpret and explain AACR2 changes as information science continued to develop. For instance, Maxwell's *Handbook for AACR2* (1997) illustrates and applies the latest cataloging rules to the MAchine-Readable Cataloging (MARC) record for every type of information format. Focusing on integrating resources, MARC addresses programs for cooperative cataloging and the cataloging needs of electronic books and digital reproductions of physical items, such as books and maps.

As information technology continues to rapidly change with the Internet and digitization of materials, a strong need has arisen to update standards yet again. While there was a process to start new revisions to create AACR3, as changes were being addressed, a decision was made to change the approach and start new standards. Work on the new standard began in 2004 and by 2005 a new approach was agreed to. The decision was made to adopt the title: *RDA: Resource Description and Access*. The reason for the change was to approach cataloging from the *digital environment* instead of the previous textual *analog* environment. This change is an attempt to include guidelines and instructions for description and access for both digital and analog resources that will also be used in a variety of digital environments (Bowen, 2005).

While new information technologies have raised questions and concerns followed by calls for fundamental revisions and discussion of the history and principles of AACR, a joint steering committee for revisions of these rules addressed these issues. Concurrently, this committee is taking into account present and future trends in information resources and information management. Many meetings took place to review the underlying principles of the rules, with a view to determining whether fundamental rule revision is appropriate and to advice on the direction of those revisions (ICPFDA, 1998).

Additionally, a separate Anglo-American Cataloguing Committee for Cartographic Materials is specifically in place to help deal with the collection and description of maps and other geographic-related materials. Representatives from member institutions and associations are recognized as experts on the bibliographic control of cartographic materials. The *Cartographic materials: a manual of interpretation for AACR2* (Mangan, 2005) was produced by this committee. Its aim is to help catalogers interpret and apply the rules given in AACR2 and additional information useful for atlases, early cartographic materials, electronic resources, and

remote sensing images. To further emphasize the complexity of agreeing to standards, it is important to point out that they come by way of international cooperative efforts. Such AACR practices come with input from the United Kingdom, Canada, and Australia.

Prior to 1950 the tradition was to consider the geographic place and date of maps as important and relevant information for indexing, but soon afterwards more maps began to appear in catalogs (Lubas, 2003). Furthermore to provide peer group help and exchange ideas, the Map and Geography Round Table (MAGERT, 2007) is in the American Library Association. It has been around since 1980, and today is the world's largest map library organization. This group provides a forum for people interested or involved in any aspect of map or geography librarianship. Map catalogers can use MAGERT to exchange ideas regarding map collections, and they can work as an advocate group for the use and control of map collections, can include regular meetings to discuss informative programs, and can meet other map professionals. MAGERT publishes is own newsletter, journal, books, and occasional papers. The cooperative work among geographic librarians is complemented in part by the use of list-servs, such as Maps-L.

In addition to agreed-upon rules, an important supplement for professionals dealing with maps is the book *World Mapping Today* (Parry & Perkins, 2002). This book provides information on the production, acquisitions, and distribution of maps and other forms of spatial data. This publication is one of the primary reference sources and research tools for anyone involved in maps and spatial data. The book provides access to information about policies and programs of the mapping industry within each country. Due to the fact that most maps are not yet digitally available or cataloged, they are difficult to find, which adds to the argument for providing geographic coordinates to library records of cartographic materials.

CHAPTER 4

CURRENT PRACTICE IN PROVIDING GEOGRAPHIC COORDINATE INFORMATION

Describing Coordinate Representations

Coordinates that are provided in library bibliographic records allow users to find specific points or areas on the earth's surface, as represented on the map. The labeling and recording of these points are governed by rules that library catalogers follow to best describe the cartographic item in hand. The paragraphs that follow will encompass the work behind providing geographic coordinate information to comply with library and metadata standards and simultaneously be easy to interpret and useful for the researcher.

A center point or two-point set system of coordinate values identifies a specific point on the earth's surface, often used to show a point of elevation or the location of a city on a map. Map catalogers historically have been providing *bounding (box) coordinates*, or a set of four points that surround some geographic region, as shown on a map (Andrew, 2003, pp. 94-95). A number of sheet maps identify the four coordinate points representing the interior area that has been mapped. The variety of interpretations of map cataloging rules leads catalogers to providing coordinates whether or not they appear on a map. This is further complicated by asking for interpolation, or rather the estimate of a coordinate value from other known information from the map, which may result in faulty measurements and human error. Bounding boxes (Figure 4-1) are the smallest boxes possible that show longitude and latitude lines with sides that enclose the extent of the coordinates of the map or the area of coverage. They are also known as *minimum bounding rectangles* (Hill, 2006).

The rule for providing coordinates is considered optional to apply, but when a cataloger uses this rule practice dictates that the coordinates are provided as a set forming a bounding box or rectangle. The push for providing coordinate information contributes to the ability of new

search engines to retrieve records using coordinates. But currently old systems are being adapted so more recent library software allows such searches in the collections represented.

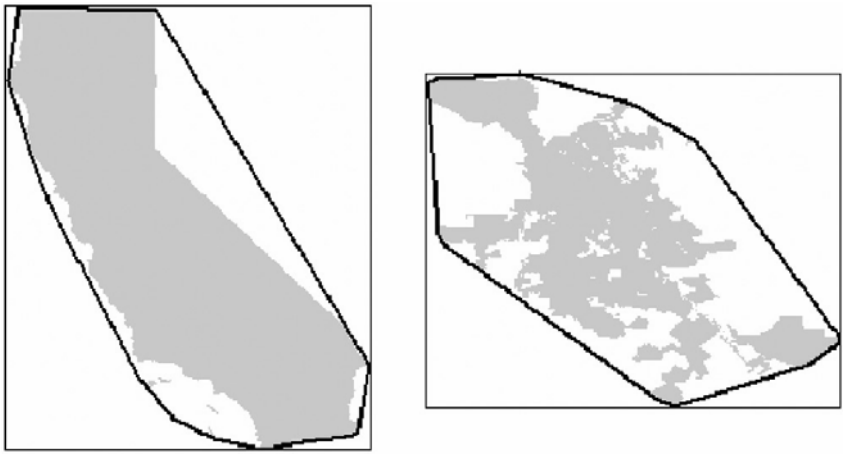

Figure 4-1. Bounding boxes are shown as the gray (thin) lined boxes; convex hulls are shown by the black (thick) lines and more closely follow the shape of the state of California on the left and the city of San Jose on the right. *Source:Larson & Fronteira, 1994.*

Scale information shown on maps is provided by the cataloger in two locations and in different formats. One of the MARC fields (i.e., components or pieces of information defined for a specific indexing application) used to display this information is the 034 (Coded Cartographic Mathematical Data) field, containing data for scale and coordinates. Scale information and coordinates, when provided, are presented in numerical form, though coordinate values also include the abbreviation in textual form of the hemispheres being covered (Andrew, 2003, p. 42). Also, coordinate data values may be given either in the form of hdddmmss (hemisphere-degrees-minutes-seconds) or as decimal degrees. The degree, minute, and second sub-elements are each right justified and unused positions contain zeros (Library of Congress, 2006).

Example of a map covering most of the Earth in degrees/minutes/seconds:

hdddmmss (hemisphere, degree, minutes, seconds)
034 1_ a ||b 22000000 ||d W1800000 ||e E1800000 ||f N0840000 ||g S0700000

Example in decimal degrees for Fairbanks, Alaska:

hddd.dddddd (hemisphere, decimal number)
034 1_ a ||d E148.778114 ||e E146.409811 ||f N065409163 ||g N64.6000099

The 034 MARC field is directly based on parts of information from another MARC field, 255 (Cartographic Mathematical Data). Present cataloging practice makes it optional to include bounding coordinates that appear on a map, but when they are included in the bibliographic record, they must be included in both 255 and 034 fields. The 255 field contains the coordinates in degree, minute, and second (dms) symbols, with appropriate hemisphere denoted, and the field must contain a scale statement as either a representative fraction when known or through the means of a standard phrase such as *Scale not given* (www.oclc.org).

Examples of coordinates in 255 field:

d m s (degrees, minutes, seconds)
255 _ _ ||a Scale 1:250,000 ||c (E 32°30'07"--E 34°30'12"/N 35°30'11"--N 35°00'00").
Bounding box for Cyprus, or

255 _ _ ||a Scale not given ||c (W 125°--W 65°/N 49°--N 25°).
Bounding box for United States.

Both fields are repeatable, meaning they can provide coordinate information for multiple maps appearing on the same sheet or additional sheets that make up the entire region. The coordinate information is provided as long as the information is present or can be estimated. Greenwich is assumed when no prime meridian is identified on the map. If a different meridian is specified on an antique map (Figure 4-2), the cataloger records the coordinates in Greenwich, but may choose to give other meridians provided in the notes area of a record (Mangan, 2005).

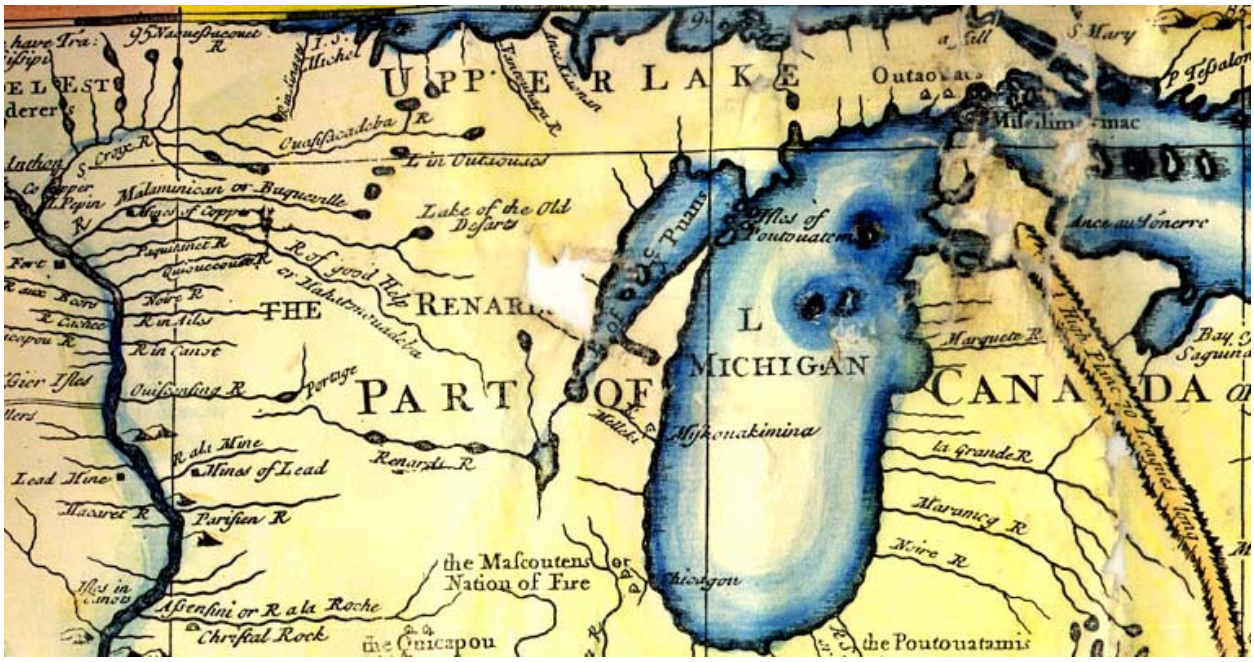

Figure 4-2. Antique map showing parts of Wisconsin and Michigan with unidentified coordinate system and outdated place names (note "CANADA" over what is present-day Michigan). From: *A Map of Louisiana and of the River Mississippi* circa 1710-1720. *Source:John L;s Old Maps.*

The coordinate grid information is also provided in a uniform way. Providing the coordinates randomly would defeat the purpose of identification, and this again helps to reduce the number of errors while allowing people to read and understand the information in a standard way. The following list is the order in which coordinates on a map are given in the record:

a) westernmost ("leftmost") longitude of the map
b) easternmost ("rightmost") longitude of the map
c) northernmost ("topmost") latitude of the map; and,
d) southernmost (bottommost") latitude of the map. (www.oclc.org)

This order is followed no matter what region is being described anywhere on the planet. As important as the order is, the mathematical expression of the coordinates is also important since the numerical representation will come closer to precision than if expressed linguistically. The bounding box representation works best for providing information on library records, and it is easy to understand despite the need to follow a uniform order. When bounding box coordinates are not available or difficult to determine, or center point coordinates have been

provided or found in an authoritative source, then the center point coordinates can be provided by repeating the latitude and longitude numbers in the above order. Since maps do not always fit a rectangular bounding box shape and can be any sort of polygon shape, they may be identified with a center point coordinate. The centroid, or the point at the geometric center of the polygon, can be used to represent the area.

Since every flat map already misrepresents the surface of the earth, one sheet of a map data-set represented digitally, as opposed to the bounding box in one map sheet, cannot show the true distances, areas, and shapes it represents. Additional coordinate information is provided in two more MARC fields: 342 and 343. The MARC field 342 is specifically created to address the frame of reference for the coordinates in a data-set, and not a single map. This field includes enough information so that the user can identify how location accuracy was affected through the application of a spatial reference method, and then can manipulate the data-set to recover location accuracy. This field also contains the grid coordinate system indicating (ALCTS, 2006).

Additionally, the plane-rectangular coordinate system is what is used, which is based on and mathematically adjusted to a map projection, so that geographic positions can be readily transformed to and from plane coordinates. Additionally, information about the coordinate system developed on a planar surface is included in field 343. This field can include enough information to allow the user of a geospatial data-set to identify the quantities of distances, or distances and angles. These distances help define the position of a point on a reference plane onto which the surface of the earth has been projected (ALCTS, 2006).

Although strict guidelines need to be followed regarding placement of coordinates, many maps do not always include the information that is required to provide accurate geographic coordinates on the metadata (Figure 4-3).

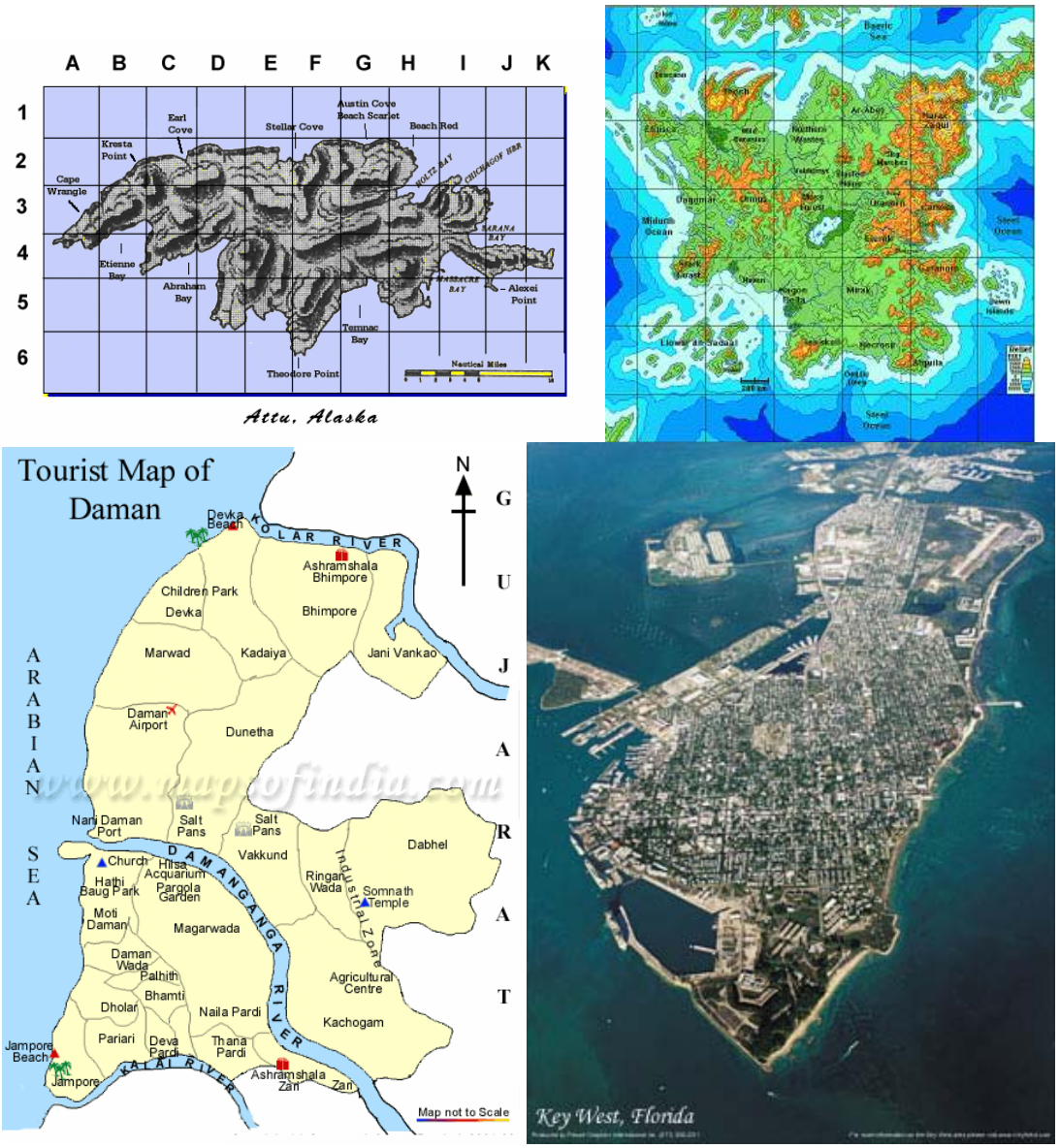

Figure 4-3. Examples of maps lacking conventional coordinate information. From upper left clockwise: unidentified alphanumeric coordinate system (Attu, Alaska), fantasy/imaginary map (Continent of Arthom), tourist map (Daman, India), and aerial photograph of Key West, Fla. *Sources (from upper left clockwise): Attu Homepage, Hiddenway.tripod.com, Resort Graphics International, and Compare Infobase Ltd.*

In regard to thematic data issues in cataloging, the textual format is critical in providing what is displayed by completely transcribing what is on the material and also coming as close as possible to correcting mistakes by providing accurate information. It is necessary also to provide a sense of completeness with the information offered from the material in hand, knowing there is other information missing. While choosing which enumeration standard to provide or convert, it

will be necessary to round out the numbers. These issues can range from what degree of propagation of errors from an original source that can be minimized to making a decision of what enumeration and manipulation of data to keep.

Comparing Coordinate Representations

Center point representation contains one latitude line and one longitude line each that intersect at a single point. It is the standard used within the Geographic Names Information System (GNIS), developed by the U.S. Geological Survey in cooperation with the U.S. Board on Geographic Names (BGN). The GNIS also contains information about physical and cultural geographic features in the United States. The database holds federally recognized names of features, and defines the location of the feature, including its geographic coordinates. It is easy to work with the GNIS to find features on maps, but GNIS is not very good for figuring out the size or shape of a geographic feature or for analytical work that helps describe parts of a larger item, collected works, or sophisticated data and--including the list of names of topographic maps. Additionally, GEOnet Names Server (GNS), also from BGN, is the supported database for the standard names of all foreign places, as GNIS is for domestic. The data contain variant spellings with cross-references to help in finding place names. The data also continue to add the native spelling of place names (USGS, 2007).

There are obvious advantages to adding geographic coordinates in a specific library data field for geographic places but problems that still need addressing include uniformity and a universal protocol that includes deciding on what system to use. The decimal form may be supplied instead of degrees, minutes, and seconds of data for sufficient advantages of retrieval and interoperability. Converting the coded form of degrees, minutes and seconds to decimal form and including both systems must weighed for benefit of ease of use versus the time and labor involved in providing such converted or dual information. The Board on Geographic Names

(BGN), a likely and optimal authoritative source for these data, provides center point coordinates, as contrasted with bounding box coordinates typically found in sheet maps, again contributing to the debate of "best fit" numbers in the information allowed by the cataloging rules. It is also important to discuss a temporal problem regarding coordinates. Should date information be provided due to the likelihood of changes brought to boundaries because of political or natural events? Also, as with most researched work, will the sources of information for these dates be provided with links to trace the origin of the information?

While these issues may be resolved later by the bodies which govern the choices of content of library bibliographic and authority records, some issues need to be determined sooner rather than later to keep up with users' needs and their ever-expanding access to information and technology. Enhancing the power of authority records, those separate records maintained and linked to various kinds of descriptive records, is a worthwhile endeavor. The enhancement is to better partner with the problem-solvers who use GIS to address our problems (Lundgren, 2005).

According to the 1994 report titled *Promoting the National Spatial Data Infrastructure through Partnerships* from the Mapping Science Committee of the National Research Council:

> The twenty-first century will see geographic information transported from remote nodes using computer networks to support decision making throughout the nation. ... Timely use of these data would be difficult due to ill-defined format, quality, and accuracy. National or regional decision making would be severely impaired because most data sets are not adequately characterized (NRC website).

Retrieval of Materials

The idea behind providing coordinates is to develop a user-friendly way of retrieving maps from a digital database. Additionally, some systems will allow users to specify census tracts, city, county, state regions, area codes, or zip codes as a spatial constraint--all ways of describing something spatially. The retrieval may be done by specifying a geographic name or by selecting a graphic map representation. Furthermore, areas defined by geographic coordinates

may be specified or coupled with a geographic/regional name, usually borrowed from an important adjacent area along with geographic type to serve as a substitute for regions with no established, known, or authoritative place name.

Regardless of what form of spatial query the database uses--geographic name or coordinate, or both--common representations of spatial data can be utilized by developing a well-defined uniformity in the description of the material. Providing spatial queries will allow appropriate and consistent treatment of the material to help in development of descriptive information for researchers and other information seekers while serving as a method to reduce errors in information. The terms *geographic* or *spatial queries* imply querying a spatially indexed database based on relationships between particular items in the bibliographic or metadata library index record, such as geographic subject headings, class numbers or geographic area code within a particular coordinate. The query can be defined with other relationships, such as intersection, containment, boundary, adjacency, and proximity to the area of the relevant map sought (De Floriani, 1993).

Providing the latitude and longitude with complete degree, minute, and second information reduces the margin of error and offers the closest approximation to the true measurement of the area on a map being represented. Maps will sometimes either leave out coordinates, or if they do include them, they may provide them using different systems than ones commonly used. The cataloger will have to rely on providing approximations for maps with no coordinate information, and will have to decide whether or not a conversion is needed to provide an agreed-upon measurement. The cataloger will also have to consider whether or not to include information as it appears on the material in addition to converted data (Larson, 1996).

The availability of spatial searching capabilities allows for interoperable services. For instance, Larsgaard (1978) identified four methods of providing geographic coding, or "geocoding" for spatial representation:

1. Using explicit boundary delineations in mathematical form, (stating plane coordinates or latitude and longitude values)
2. Using nominal values that do not indicate spatial relationships among entities (place names)
3. Using ordinal values to indicate relative positions of spatial units within some defined system, such as census tracts
4. Using unique designations for undefined or implicitly defined locations, such as zip codes

One of the important contributions to geocoding is the benefit to multiple applications. All coordinate-based implementations can be translated to other coordinate-based implementations, albeit with the risk of losing positional accuracy. Although coordinate values can also be translated to place names by arbitrarily or authoritatively assigning names to sets of coordinates, many, if not all, cartographic materials, such as aerial photographs, satellite images, and antique maps, do not have such assigned names. The transportability of the information is from or to different sources or the information needs to be consolidated to a same location identified differently by different sources (e.g., USPS, Sanborn, U.S. Census). On the other hand, a daunting task identifies, digitizes and codes all areas identified on a map. So there is a trade-off as to the level of accuracy your information can be (Sears, 2004).

Map Services and Mapping Tools

This section will attempt to look at the different available databases to provide a variety of ways of searching and providing results. This section will also explain how libraries can benefit from the services they provide to improve a library's online catalog.

Google Maps is a service offering powerful, user-friendly mapping technology. This technology includes integrated business search results to help find business locations and contact

information. The maps can be clicked and dragged that allows viewing of adjacent sections. Google Maps also provides a layer of satellite images to view desired locations in that format. As in other address-oriented online maps, it provides detailed driving directions; along with the standard shortcuts and arrow key use for panning the map in different directions and includes zooming and scroll abilities. Another Google service, Google Earth, displays 3-D images and supply coordinates, but it has not made the coordinates a searchable indexed element to date (Gurnitsky, 2006). The shortcomings are very apparent when its limits are realized by way of the number of maps it can produce. Google Earth is neither a warehouse nor a collection of different types of maps as libraries are, and it does not provide a thesaurus or cross-referencing of variant names.

The Alexandria Digital Library (ADL) includes datasets of U.S. topographic map quadrangles, and parts of the GNIS data from the U.S. Geological Survey have been added. The database allows the user to search for place names, which includes both primary names and *variant* names for the geographic location. To help with the establishment of one standard place name from many alternative spellings, ADL provides a general way to specify the type of feature in the query. Narrower terms of a selected feature type are included, allowing browsing to find related words; for example, to look for farms in an area, the user can find out that they are given the general type of *agricultural features* (ADLP, 2004).

The Alexandria Digital Library Project (ADLP) has the advantage of developing a georeferenced digital library that holds both textual and geospatial resources that provide geospatial description and access for all resources. Coordinates are used to represent the location of features on the surface of the earth. The coverage of maps, aerial photographs, remote-sensing images, and datasets of various kinds and coordinate place referencing have been associated with

resources that have been treated by information management systems whether text-based systems or GIS (Hill & Janee, pp. 1-2). This service provides a single map for location and does not produce the plethora of maps that can be found in a map library collection.

An ideal search query is able to integrate a feature type thesaurus into the search interface for the gazetteer. For querying cartographic materials, they definitely need to be digitized and geocoded. Georeferencing is the process of taking a street address, by way of a point on a map identified by geographic coordinates, and converting it into decimal latitude and longitude coordinates so that they can be displayed in a map database. When trying to locate the segment, the following geographic references may all be used: street number, street name, street direction, street type, and the city, state and zip code. The georeferencing is what makes locating addresses and viewing multiple locations on a map instantly possible.

The benefits of a gazetteer include the use of geographic coordinates, which can provide the basic structure for named places using map visualization software. Georeferencing is the intersection of one line of latitude and one line of longitude. As the use of map interfaces increases, more complex georeferencing, such as using two lines of latitude and longitude to form a bounding box and polygons approximating actual boundaries, is needed (Buckland, 2007, p. 381). A georeferencing calculator (Figure 4-4) is a tool to aid in the referencing of localities of digitized items, such as maps that are found in a library, museum, or similar collections. Displaying the position of a site geographically can help detect errors and increase data quality. The GIS tools contain analytical functions which make possible the prediction of spatial distributions (Wieczorek, 2004, p. 764).

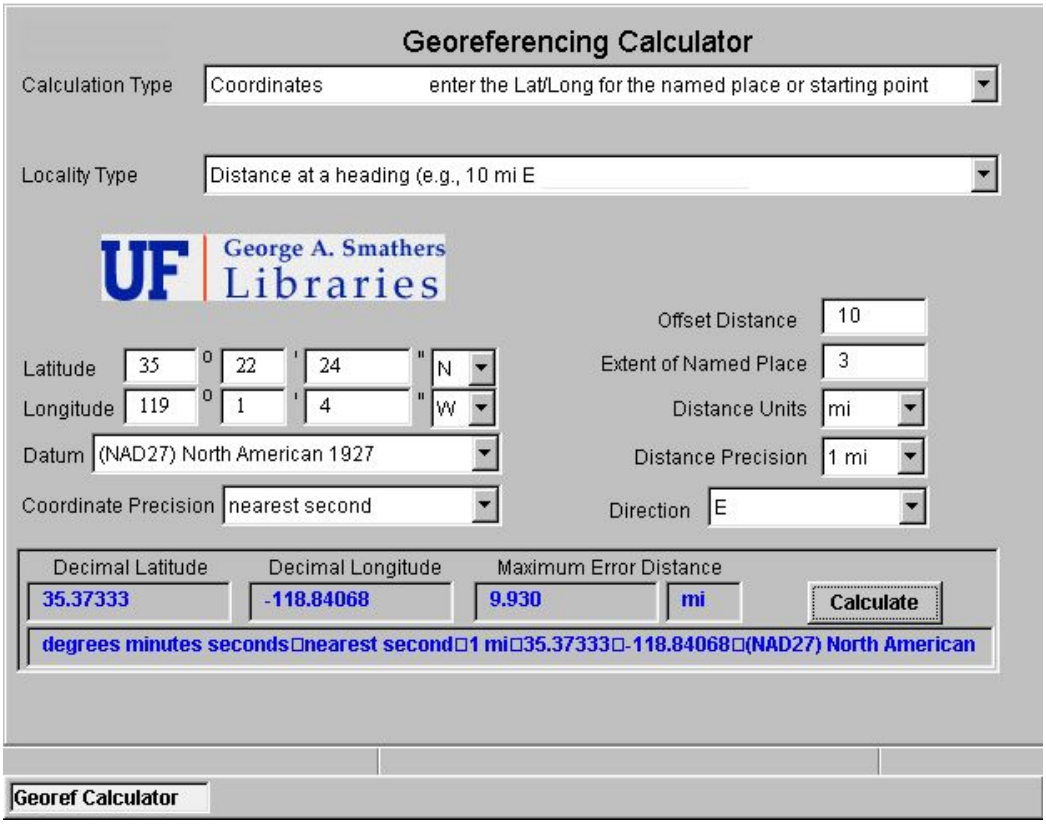

Figure 4-4. Sample of a georeferencing calculator for UF Libraries – Search for Los Angeles.

ArcGIS contains a tool that allows geographic interfaces to bibliographic citations and library records offering graphic alternatives to searching text strings of place names. The ArcView's *hotlink* tool permits linking to external data utilizing a point for each of the place names created from the associated latitude and longitude fields. Using this functionality, the user can look at a map, click on a point in an area, and retrieve relevant bibliographic records in a new window. The same type of Universal Resource Locator (URL) search can be created for any library catalog or database that is capable of linking to remotely generated URLs (Wright & Urban, 1996).

Database Discussion

Maps are an integral part of data researchers' need for emphasizing the relationships between place, time, and subject in the study of culture, environment, architecture, engineering,

and history. In an effort to enhance map retrieval with better tools and standard practices by way of digitization, software must be developed and manipulated to allow downloading and editing of geo-temporal data to manipulate the representation as well as editing the data if needed. This interface will be improved by the availability of shared data accessible through map-based interfaces, standards for gazetteers and time period databases, continuous research, studies to develop and improve geographic aspects in online catalogs, and good practice guidelines for preparing paper and electronic publications (Buckland, 2004).

In order to display information in geographic tool software, map data must be georeferenced. To create base maps and contribute additional map layers, the map data must routinely include data with latitude and longitude attributes, along with the use of place names collected in the course of research on historical texts or actual material in hand. The Alexandria Digital Library (ADL) is one powerful player on the authoritative level of selecting place names for this kind of work (Hill and Zheng, 1999). Regarding thematic concerns, even the flexibility of converting coordinate information and despite the ideal of uniform data, the information will be dependent on the researcher carrying out the queries and having an understanding of the database that provides the necessary information.

Geographical Searching in Library Catalogs

Library catalogs have been designed, or are best known, for searching by author, by title, and by subject, but they are in the process of developing their spatial searching capabilities through the application of GIS and providing additional numerical data. The user can search for place names in titles, keywords, or in subject headings, but geographical headings tend to be political jurisdictions or of an administrative nature. These names tend to depend on current use and can be burdensome for historical or political changes.

Geographic coordinates, however, along with the place name feature, are effective in selecting different places with the same name and associating different names for the same place. The idea that GIS will allow data with coordinates to be visualized as map layers in a common coordinate system conversion from other standards. Multiple map layers, showing other divisions by topic, among them history and topography, for example, will be superimposed in a single viewing environment. Coordinates for place names in subject headings will allow for retrieving maps by clicking on a referenced dot.

Additionally, geographical coordinates will be calculated in the form of *nearby* searches by perhaps defining a radius around a center point, making this useful for border and frontier studies along with studies of near neighbor effects. With today's technology, the linking of online library catalogs with online gazetteers alone could transform geographical information searching throughout the libraries and the Internet (Buckland, 2004).

Searching a geographically indexed database assumes that the searcher is able to specify what he seeks. Furthermore, the searcher will be able to input the information in some type of query language or provide coordinates in some way, but not necessarily in some standard query formulation. Pointing at interactive maps can give the desired results of the coordinates, and they can be used to formulate the search by providing that information to the spatial query (Larson, 1995, p. 91).

The University of Florida library catalog can include a link to a different window that will allow the user to search by bounding box or center point coordinates (Figures 4-5 and 4-6). The researchers using the library catalog would be able to search the database by entering coordinate information.

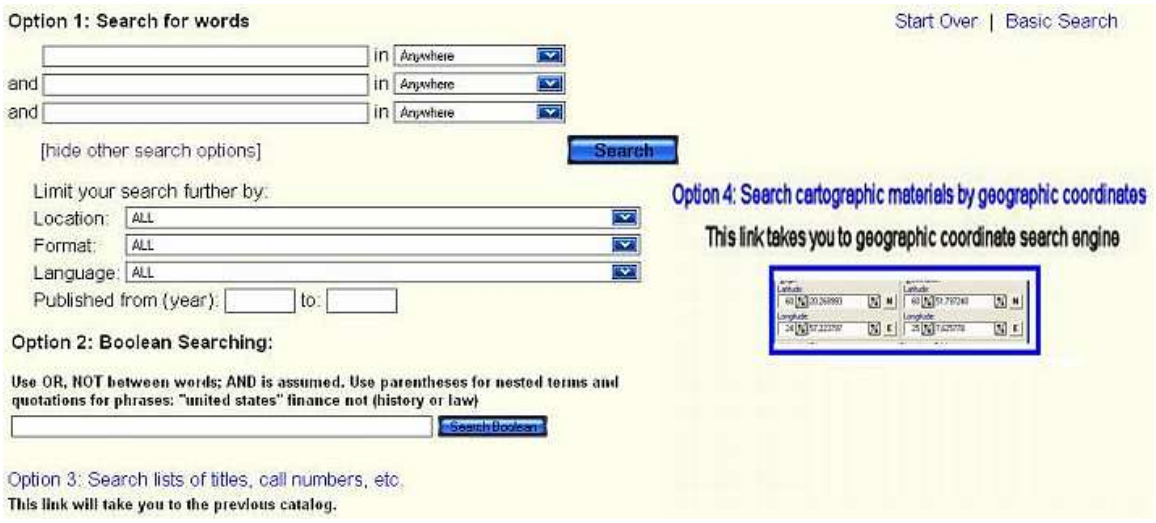

Figure 4-5. Sample screen accommodating link to expand search to geographic coordinates.

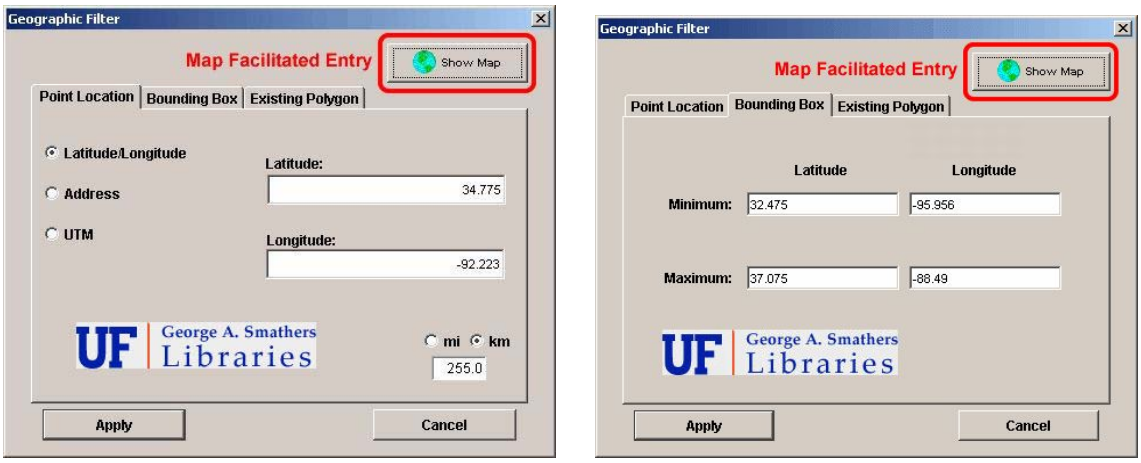

Figure 4-6. Sample screens accommodating geographic coordinate searches for points and for bounding box (Qinchai Province, China).

CHAPTER 5
CATALOGING ISSUES IN PROVIDING GEOGRAPHIC COORDINATES

Addressing Boundary and Accuracy Issues

This work concentrates on the problem of providing cartographic information, and, more specifically, coordinate system information, for the cartographic material being described. The map cataloger is used to providing all kinds of spatial information to describe maps: scale, projection, source, and place names. Other non-spatial information is also included: title, author, subject (non-geographic) terms, type, edition, and situation date. All these descriptions provide many of the elements necessary for the needs of spatial resource users, and they do so in a variety of approaches and interpretations under a uniform standard.

Additionally, boundaries are lines determining the limits of an area and can have many meanings, usually depending on what function they serve along with the perceptions of those who live in their proximity. Boundaries are authenticated or legalized by being depicted in documents or on lines drawn on maps or on land or sea through the placement of markers or checkpoints. Disputes regarding boundaries come about from broken treaties. From differing map representations likely from overlapping territorial claims, and from heavily concentrated militarized areas along disputed borders. The resulting spatial changes from boundary conflicts are linked to broader processes affecting divided countries and from people not necessarily wanting to be divided (Wood, 2000). This, in turn, affects search retrieval border, geographic line identification, and labeling in maps, while both cataloging specialists and researchers try to avoid taking a political stance or attempt to remain neutral in definition (Figure 5-1).

Boundaries also tend to symbolize the chaotic, frustrating and sometime warring tension among groups with hopes for self-determination and internationally recognized sovereignty. The value of a legally recognized boundary can be beneficial for the people affected by its parameters

whether the value may have been placed through historical events or other functions that led to national identification (Wood, 2000). An effort must be made by both librarian and researcher to identify the geographic coordinates of the disputed area for searching and retrieving said materials.

Figure 5-1. Sample of a border dispute of Kashmir region. *Source:GNU Free Documentation License.*

The ability to understand geographic coordinates is critical to map reading. As the grid reference remains significant to print maps for locating places, coordinates will continue being useful in the digitized realm and available as long as the Internet is available (Wiegard, 2006, p. 36). However, many of the spatial metadata elements are retrieved in manners unique to individual systems. Therefore, limitations must be noted to providing coordinate information both from within the cartographic item and via established library standards. Also it must be noted that additional limitations exist once the information is provided.

The spatial coverage of a cartographic source shares attributes with other information sources, such as books and journals and sharing title and subject terms. Cartographic materials will differ from these other formats that usually come in the shape of a rectangle, and they may contain coordinates to identify the rectangle's corners. Most, if not all, text-based information systems have not used geographic codes for retrieving materials. Many map collections still rely on the knowledge of their librarians to help patrons find what they are looking for. A demand exists for a new powerful spatial information searching tool for improving the efficiency and effectiveness of searching geographically referenced materials (Yu, 1999).

This digital age has made cartography and geographic information more integrated than ever before, making spatial information more critical for representing traditional cartographic manifestations. Librarians must be able not only to provide data which traditionally represented cartographic documents, but now provide accompanying metadata from such sources that may contain any sense of locality (Smits, 1999, p. 304).

Ideally, providing geographic coordinate information depends on the availability and completeness of the metadata provided and also the discretion of the cataloger following policies in place. Libraries are on the cusp of not needing to provide long bibliographic records with publisher information, but must otherwise provide metadata that can be loaded and converted to a database for indexing purposes (Welch & Williams, 1999, p. 353). But users fail to see that the metadata has to originate somewhere and that standards must be adhered to.

Accuracy of data is important for maintaining uniformity and easy communication and transportability/exportation of information. The following factors can all be considered as a means of reducing errors and increasing accuracy when creating bibliographic information:

a. Documentation of the data by way of cataloging
(documenting bibliographic information of library materials helps preserve data, that is, that data's legacy and longevity for future use)
b. Viable transfer of data and the data's documentation through metadata
(metadata is used for improving document retrieval, as well as supporting and transferring data information from one collection to another)
c. Agreed-upon symbols and numbers for presentation
(using the same kind of symbols and punctuation reduces interpretation of existing symbols and eliminates duplication of symbols to mean other definitions)
d. What elements of content will be presented?
(agreed-to elements help save time by working with already established terms and help with communicating in said terminology)
e. Which format(s) it will be distributed in
(materials in the library may include many types of materials; primary sources may also later be reproduced in another format whether book, photograph, map, atlas, compact disc, or microform)
f. Intent behind the creator's map
(visual approach: map for instruction or for highlighting statistical information or for re-creating an event--all may help identify subject identification)
g. Consideration for international bodies and open sources
(material copyright or licensing issues versus equal access to all)
h. The dominating approach behind laissez-faire industries driving the preferred or monopolized use of metadata standards
(legal issues tied to duplication of material or effort to reproduce material in different formats)

Standards are for facilitating the development, sharing, and use of, in this case, spatial data. Agencies, such as the U.S. Federal Geographic Data Committee (FGDC), develop standards for implementation, and sharing and use of spatial data on a national level. The FGDC does this in consultation and cooperation with state, local, and tribal governments, the private sector and academic community, and, to the extent feasible, the international community. Standards and uniformity contribute to common or "agreed-upon" ways of cataloging and supplying spatial information to bibliographic records and metadata. As such, data built to standards are more valuable since they are more easily shared, again, through the use of metadata.

Cartographic materials, including maps, atlases, and satellite images, are cataloged according to the latest national standards for descriptive content and punctuation. These national standards are included, as previously mentioned, in the latest revision of *AACR*, Second Edition, Second Revision, and *Cartographic Materials: A Manual of Interpretation for AACR2*, 2002 Revision (2003). Local standards and variations to more specific rules are also taken into consideration, usually applied to special projects or formats and recorded online for the benefit of the department staff and to maintain uniformity and accuracy.

These standards call for taking the information from the map or source itself or the principal sheet for a set of maps. If finding the source fails, the searcher may use the container or other accompanying material, in that order, as the source of information. Important information that is used in the description of a map includes: title(s), author(s), geographic subject headings (place names) represented on the map, date(s), physical description, scale, projection, type of relief, and geographic coordinates.

Geographic coordinates are useful and important in their ability to precisely specify positions on the earth's surface. Their uses include comparing positions, calculating distances, and, in general, assistance in navigating from one point or place to another.

Cataloging work and the creation of metadata is detail-oriented. The following factors must be taken into account in order to reduce the number of errors as much as possible:

a. Exactness of measurement or description of material in hand
b. Degree of correspondence between the data and the real world
c. Authoritative control of the input data
d. Reliable sources for the data and the processing steps it takes to carry out the work
e. Degree to which the data represent the world at the present moment

Accuracy, or completeness, can be measured by the discrepancy between the encoded and the actual value of an attribute or by the number or lack of errors. In turn, this completeness can

include precision which can be described as the degree of detail that can be displayed in time, space, or topic as subject entries, and includes maintaining a consistency which is the absence of contradictory information in said database. Among the quality issues mentioned regarding cataloging cartographic materials, the following issues have to be confronted:

a. Spatial precision when providing the actual coordinates
b. Accurate measurement of materials
c. Not providing coordinates (or working with missing data)
d. Consulting current source data for carrying out updated revisions

While simultaneously providing local interpretations to procedural rules, which, in turn are susceptible to such errors in human definitions as:

a. Uncertainty of measurements
b. Not following up on discrepancies
c. Prioritizing or deciding what information to leave in or out
d. Converting data to internationally accepted standards or other local standards

Accurate information is vital for effective results in the information-providing world. The information will be relied on by individuals, researchers, and even government agencies. Accuracy is an essential component in the decision-making process in producing the most accountable information. Bad decisions contribute to the absence of reliable, accurate information, and increase the chances of producing a product that will impair or flaw the scientific process. Data are susceptible to human inaccuracy and conditional to what gets measured and what gets ignored.

Advances in technology, as in the digitization of materials, are increasing the range of what can be measured. Since library science has been involved in the business of providing information, librarians--specifically catalogers--find themselves increasingly involved in providing more information. The human factor in the increase of providing information makes

users susceptible to more inaccurate information. So standards must be constantly reviewed to decrease errors or at least keep to a minimum the number of errors.

Metadata Language Use

Libraries rely on the MARC (MAchine Readable Cataloging) format, which has been criticized for some shortcomings relevant to digital spatial data. In reality, no other metadata scheme is so carefully reviewed, revised, amended, and so universally in place as is the MARC format for library materials. Ercegovac and Borko argue that use of the MARC format "requires cataloger's memorization of a large number of rules, which change frequently" (1992, p. 267 as quoted in Franks 1994, p. 13) Additionally, MARC contains many variants and interpretations among different interest groups and committees that have led to a few problems in exchanging bibliographic data (Frank, 1994, p. 23). While the MARC record format contains fields that identify spatial data, including map scale, projection, or map bounding coordinates, the use of such fields is inconsistent. Some of the information that can be provided is optional for the cataloger to provide.

Additionally, the Federal Geographic Data Committee (FGDC) initiated work in 1992 via a forum on geographical metadata standards. Its objectives are to provide a common set of terminology and definitions for the documentation of digital geospatial data. The standard establishes the names of data elements and groups of data elements. By Executive Order 12906, *Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure* was signed in 1994 by President Clinton. The FGDC invites and encourages organizations, government agencies, and persons to use the standard when documenting geospatial data (FGDC, 1994).

Few spatial data representations are more basic than the bounding box: a rectangle surrounding a geographic feature or dataset. Bounding boxes are key components of geospatial

metadata, especially if the information is supplied. Despite their common use, bounding boxes are more complicated than they first appear. Bounding boxes are one of a number of methods for describing the extent of a map dataset. The bounding box is supposed to represent "the limits of coverage of a data set," but the meaning of limits is not clearly specified in the Content Standard for Digital Geospatial Metadata. The phrase that *spatial is special* applies to this humble representation (Caldwell, 2005).

A continual cooperative effort has been made among the national, state, and local library communities and organizations to identify, address, and solve these problems. Currently, many bibliographic databases, which use MARC formatted data, limit users to searching for information based on the spatial metadata supplied. Despite some apparent shortcomings, MARC continues to be the primary choice for integrating bibliographic data in the library community due to its versatility and well-established nature, that is, it is true and tested (Frank, 1994, p. 90).

The MARC's geographical searching limitations include restricting the search parameters to a particular location in space. The searching is done by specifying a place name or by applying geographic coordinates, if supplied by the cataloger or already available on the record. Place names can be ambiguous, having different meanings among different users (e.g., Las Malvinas v. Falkland Islands), and can suffer from variations in spelling (e.g., Colombia v. Columbia). Place names are commonly used as a retrieval key in most bibliographic systems (Hill et al., 2000). However, this work is about providing and establishing uniformity in coordinate systems.

For a map, one of the most common methods of describing spatial constraints is to specify a center point location and search radius, or, preferably, to specify diagonal corner locations of a minimum bounding rectangle or *box*, or also to specify the locations of vertices of

a polygon within which the searcher would expect the data to exist. Authoritative database systems, such as the Alexandria Digital Library, U.S. Gazetteer (U.S. Census Bureau), GNS, and GNIS, offer one or more of these geometric constraint methods to users. Other spatial constraint methods currently used to specify a satellite path and frame number for remotely sensed imagery or specify a *tile* of a hierarchical order (Frank, 1994, p. 90).

The thematic data issues for using and providing metadata include a constant awareness and knowledge of current data. Data needing revisions and updating pose a challenge with missing data in regard to compensating or noting the absence of the data.

CHAPTER 6
SUMMARY AND CONCLUSION

From the findings, library staff needs to work toward a common goal of seeking how to use information technology to support policy, facilitate library use, and make learning interesting for students and researchers desiring to use the library as their primary resource of information. To complement, or rather keep pace with, the increased Internet use and meet users' demands while lessening existing anxieties or apprehensions, library staff may also have to encourage users to take the plunge and walk into a library. Educational technology coupled with information science can be used to enhance teaching and develop methods to increase patron library use.

This work is written to provide an understanding of the work that is involved in cataloging and providing metadata for cartographic materials and the factors that contribute to thematic errors. To demonstrate what is involved in cataloging maps, it is necessary to understand the need for providing spatial data as the basis for geographic information retrieval. This work concentrated on one aspect of spatial data: geographic coordinates. The ideal is to provide coordinate information for the purpose of facilitating document retrieval while concurrently encountering, resolving, or minimizing any of the following problems: accuracy, consistency, conversion, and unavailable data.

The development and use of spatial information and metadata cataloging patterns have depended on and grown along with the advances in information technology--with what computer memory has allowed. The recent library information shift has created a crisis in the establishment of standards to keep up with the changes. These information developments in turn affect the information that is input at the local level at the University Library. The AACR2 rules have given way to a much delayed introduction to new standards: Resource Description and

Access (RDA) to tackle the new challenges in describing digital resources in the new Information Age (JSC, 2005). However, it may be a long time before the number of solutions can be reduced or before a single solution can be found or agreed upon in regard to providing spatial information to library records, and maybe even longer when finally applied at the University of Florida Libraries. Despite these minor setbacks, library science will continue to have a workable information infrastructure using the latest methods and sources for providing and locating spatial resources.

Despite some aforementioned unresolved issues, including competing online geographic gazetteers and a shortage of new standards to keep up with technology, catalogers can forge ahead knowing that applying the practices mentioned in this work will be one way to confront the problems and reduce errors. The ideal query situation includes being able to search most, if not all, maps in a library collection by way of geographic coordinates, and thus find every map that can be pinpointed within that coordinate range.

The map collection database at the library must be able to go beyond the service of gazetteers and provide many layers of maps in an instant. It must be understood that providing coordinates cannot be a panacea. But the coordinates must work in conjunction with place names and feature topic names and probably beyond to a subject/topic thesaurus and hierarchical relational data, that is, planet, hemisphere, continent, country, primary level administration, secondary level administration, city, neighborhood, among other geographic regions.

It is hoped that identifying the hurdles here, as well as those that information providers and researchers will encounter along the way as they are put into practice, will make it easier in the near future to keep up with the fast-paced changes in information technology. Librarians must not be frustrated by the number of problems to be overcome, but instead be resilient and

progressive in thinking to move forward with this technology. Through cooperative efforts at every level, it is important to make the necessary and, in some cases, overdue adjustments in standards, procedures, cataloging rules, and information retrieval services among the contributing and authoritative parties. These efforts will be for the benefit of all those needing access to this information.

One positive—or perhaps negative--aspect to consider about information technology may be that the user can never consider the work finished because it becomes more a set of interdependent information. Thus layers upon layers of information will be a fit in different sources, and these layers of information will need to be constantly updated and revised, as well as the metadata infrastructure. At the same time, the advent of the Internet, its resource use, and contribution have expanded beyond all expectations. The Internet is having a significant impact on research work, thus making for a need to have an inventory of information and consequently common standards.

The librarians' response to the spread of information, of course, is not free of challenges which include a lack of familiarity with the technology, and the need to develop appropriate content for the databases for both defining standards and gathering information while making the data suitable for comparative work. The information science fields, whether library information science or geographic information science, will be expanding their use more and more, as in recent years. Geographers must again be the creators and users of the software programming and application that will deal with the matter of spatial data. Teachers and librarians will take on the responsibility of teaching future students and researchers the new skills necessary in conjunction with the direction that information science is taking.

Furthermore, digitized spatial data see no end in sight because an unwritten directive to is to digitize every bit of information available, coupled with coming up with more and more layers of information to integrate to the existing digitized information. Once a spatial data object has been created or needs to be classified, it will also need to be constantly updated and edited, depending on the editing of the material or catering to the patrons' needs or requests. Catalogers--whether digital or map librarians, or better yet, maybe geographers--will become the GIS managers occupied with developing, creating, editing, and validating inputs and standards for spatial data. One uncertainty is how great the growth of databases will relate to the digital spatial objects. Another uncertainty is how far librarians, geographers, and researchers can go discovering new data and text mining processes.

Today, information technology provides a possible new application for modem geography. Henry Tom (1994), the GIS director for Oracle Corporation working on metadata standards, stated that these GIS standards offer an unprecedented means for the GIS world to interact on an equal and mutually beneficial basis with the world of information technology standards. The University of Florida Libraries can benefit from more geography and GIS professionals. But it is important that geography will create an agenda that includes the appropriate curricula to establish what will serve as a base for uniform spatial information and library information standards for manipulating, classifying, and retrieving spatial information. Such an infrastructure serves not only as a standards forum, but it also establishes a community of concern and ownership in developing specifications to resolve spatial issues common to all. For a successful collaboration, library digitization and cataloging issues must also be resolved.

Challenges include recognizing how spatial data from digitized materials can be formulated into the integration of spatial analysis in both the curricula of social scientists and

information retrieval and access. Geographical information science has traditionally been within the realm of geography departments, but in a number of places GIS programs and degrees are offered in a multidisciplinary and interdisciplinary environment outside the traditional departmental boundaries; the question remains whether a restructured GIS approach in geography will claim this terrain or if this constitutes a threat to its traditional role. These issues will require considerable debate; they seem far from resolved at this point. In addition to the matter of who will provide the education, much work remains to be done to integrate even basic notions of spatial analysis into mainstream social science curricula.

An underlying theme of this work is that "space does matter," although this may not be immediately evident in the social sciences. An important challenge to the spatial analysis community consists of demonstrating in clear terms that much is to be gained from the discipline of geography by a careful and explicit approach that incorporates spatial elements in social science research.

Many developments in new technology and information sciences form the foundation for a growing importance of spatial analysis. This is an exciting frontier and it probably brings significant gains in the technical skills, theoretical skills, and knowledge associated with geographic information science. In order to accomplish some significant advance, data analysis and computation will continue to be necessary. In addition, these advances are likely to continue in interdisciplinary environment where traditional boundaries are brought down. It is a challenge to the geography and information science communities to seize this opportunity and provide the means to develop spatially integrated programs.

Information retrieval based on geographic information is just beginning to take a foothold in information research; therefore little research has been done to evaluate the effectiveness of

searching by coordinates. For now, place name queries are sensitive to language and grammar issues, and a name is not available for every place on the planet. The idea for the use of coordinates is that every place can be identified by geographic coordinates (Hill, 2006).

Robin Kearns (2001, p. 306), from the University of Auckland, New Zealand, summed up what is being communicated in this work:

> At the start of a new century of geographic endeavour, it behoves us to take seriously what the public thinks of our world, and thinks of us as interpreters of it for much of our teaching and research is shaped by trends in society at large and the spirit of our age. While shaped, we should also be shapers and contest the processes that might otherwise be constructed as inevitable. Ironically perhaps, geography become history to the extent that we restore the story of geography and broader perspectives on people and place to our curriculum .... We need to endorse the primacy of place experience and recognise the university and community as mutually interdependent sites of geographical education. While we might doubt our abilities to change the world at large, if we critically influence the worlds of others, they, in turn and in time, may positively change ours.

The future of the University of Florida Libraries will depend on library science and geography. Both geographic needs and library information's needs for providing academic research will only grow and become an increasing part of our information consciousness. It is necessary to become more familiar and skilled with the technology and be more spatial-literate. Establishing standards continues to be important, especially standards for metadata. The ability to use the Internet and GIS continues to grow not just for the ability to access static information, but also the ability to interact with and manipulate the data online. And librarians must work with geographers to take on more managerial roles in the design and provision of GIS services, leaving the technical aspects, ideally, to specially trained geographers.

This work by no means needs to be the end but rather the beginning of a larger project. Spatial information can be found in many other sources besides cartographic materials. When looking at documents concerning agriculture, census information, biology, ecology, archeology,

and geology, all of these among others are concerned with a particular location on the planet, maybe even the universe--including astronomy. In traditional library catalogs, materials are mainly accessed by subject matter or call number, but not always by geographical data (Smits, 2000). Cartographic materials must use the unique mathematical properties they provide in a time where this information is readily available and becoming more prominent, and they must consequently integrate or develop geographic information browsers that can perform the functions to carry out coordinate searches.

This work has demonstrated a need to address the changes occurring at the University of Florida Libraries in regard to information technology, especially the way cataloging methods affect metadata production. University librarians and geographers must embrace the changes in information sciences and work together to improve the way spatially referenced information can help with the dissemination of information and improve access to research materials that will be available not only to researchers but of everyone else. The apparent instantaneous changes, which occur with the availability of immediate documentation results on the Internet, must not discourage information keepers (librarians) or information seekers from working together to create better methods for storing and retrieving information. Librarians, who have the rules and the standards in place, and geographers, who have the tools (GIS) at their disposal, must make themselves available and make others aware that they have the potential to create a system that will clarify the muckiness of unrelated results from endlessly wading through full-text searches on the Internet.

APPENDIX A
SURVEY WORK AND ANALYSIS

The survey administered hopes to convey the researcher's dependence on geospatial information. The survey was distributed to graduate students in geography, placed in the map library, and handed out in an urban planning GIS class. It is hoped the survey can help provide feedback and eventually be used to improve search capabilities for cartographic materials, and also help find additional materials in a more efficient manner. The University of Florida Libraries may determine which books, magazines, videos, CDs, and maps they acquire, but are they looking at what researchers need? Should the University Libraries be developing a role with patrons to adequately provide queried information? Library services have tended to ignore the traditional needs of the patrons. A study conducted by Gluck (1996) showed a need for geospatial information,

> To connect with others and to imagine and dream. All geospatial information is not as ideologically or practically based as our current library services and products seem to dictate. People use the current products and services but modify them for their needs. We should be sensitive to those transformations and provide support for them.

From the survey (Appendices B and C for survey sheet and complete results) carried out April to May 2007, it was revealed that more than 70% of geography-related researchers at the University of Florida relied more on the Internet and other sources compared to using the physical library (~25%) to research and retrieve materials of a cartographic nature. Whatever independent or across-the-board recent trends or what other subject or library branch experiences may be, the numbers seem to reflect a higher dependence on the non-physical library resources than on the actual physical buildings where professional help is readily available.

The survey also shows that researchers at the University of Florida look for all types of cartographic materials when searching the library database: census data, demographic information, digitized data, GIS materials, statistical documents, aerial photographs, satellite images, atlases, and other items such as CDs and DVDs containing maps and cartographic information (Figure A-1). But almost half of those surveyed could not answer if they were finding an adequate amount of materials of cartographic nature; the remaining half was split almost evenly between yes and no. A majority of those surveyed also responded that they did not find an adequate amount of materials of a geographic nature in the libraries.

Those surveyed also expressed from a supplied list that a library listing of geographic materials can be improved by having more geographic headings and more geographic notes, acquiring more print maps, increasing access to staff, improving geographic literacy, and having more coordinates information. About 25% of those who responded to the question on whether or not they rely on latitude/longitude to help retrieve cartographic materials answered yes. Furthermore, when asked if coordinates or place names would be their preferred searching method for maps, the majority with a preference chose both coordinates and place names as their answer instead of opting for just one.

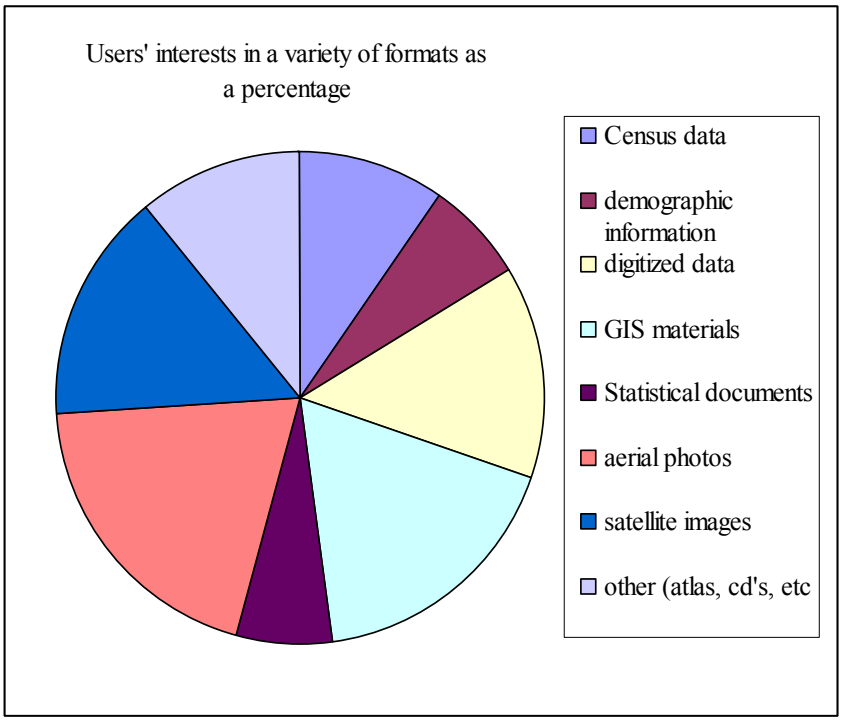

Figure A-1. Users' interest in a variety of formats as a percentage

A strong number of those surveyed also wanted to reinforce their search queries with both place names and coordinate information. Given an opportunity to express other problems that they encounter when searching the library database, some recommended more indexing of topographic maps, creating links to the Florida Geographic Data Library (FGDL), which is maintained at the University of Florida's GeoPlan Center, plus a GIS Research and Teaching Facility that is the mechanism for distributing satellite imagery, aerial photographs, and spatial (GIS) data throughout the state of Florida (FGDL.org).

Clearly the results largely reflect graduate student participation and needs. A significant amount of inclination is shown toward digital format rather than paper materials, which probably reflects what most people are looking for these days. So an electronic search by geographic coordinates or bounding boxes is indeed a logical idea. Unfortunately, faculty and researchers were not as emphasized, and more information would have been useful from other departments (i.e., forestry, archeology, anthropology, and other users of GIS).

APPENDIX B
SURVEY RESULTS

(Question 1) Are you?

Category	Count	Percentage
Undergrad	1	2%
Graduate	35	85%
Faculty	3	7%
Staff	0	
Visitor	2	5%
Other	0	
N=	41	

(Question 2) While searching the library catalog do you look for (and find or use) any of the following information or formats of publication?

Category	Count	Percentage
Census data	9	10%
Demographic information	6	7%
Digitized data	13	14%
GIS materials	16	17%
Statistical documents	6	7%
Aerial photos	18	20%
Satellite images	14	15%
Other (Atlas, CD's, etc.)	10	11%
N=	92	

(Question 3) Do you find an adequate amount of materials of a geographical nature in the library database?

Category	Count	Percentage
Yes	11	27%
No	10	24%
Unsure	20	49%
N=	41	

(Question 5) How do you think library listing (cataloging, or description) of geographic materials can be improved to assure you have done a thorough search of the library catalog to satisfy your needs or requirements or, what can be done to help you get the most out of your search? Providing:

Category	Count	Percentage
More geographic headings	8	22%
More geographic notes	7	20%
More coordinates (lat/long) info.	3	7%
Acquiring more print maps	6	15%
Increasing access to staff	2	5%
Improving geographic literacy	8	22%
Other_____ *	5	2%

N= 39

Other responses (5):

Create links to FGDL

I haven't really noticed

Upload more map images to Internet

Digitized maps

Not sure unfamiliar with system

Question 6
Do you find an adequate amount of materials of a geographical nature in the library database?

Category	Count	Percentage
Yes	9	26%
No	26	74%

N= 35

(Question 7) Would you prefer searching **latitude/longitude** or geographic **placenames** to find maps? Or **both?**

Category	Count	Percentage
Latitude/longitude	2	6%
Place names	14	42%
Both	17	52%

N= 33

(Question 8) What other problems do you generally or specifically encounter when searching the library database for geographic/cartographic materials?

Have not visited
Need more helpers
Metadata not available before downloading files
Lack of experience with the process
Not adequate materials
Don't use the library
I do not use the library databases. Maybe what is suitable be more widely publicized
I use the Internet, not the library catalog
Keyword searches are pathetic. It is very difficult to find materials.
Mostly perform regional searches so place names work just fine
Lack of certain aerial photographic series
Not knowing where to look or search for information
Should have indexes (online) for togographic sets with just a single record/call number
I'm new, I haven't started to do this too much yet
I used only once the Map Library
Shortage of data
Slow response from server, hard to find some images for different years
Printing/scanning maps
Never really used it, ashamed to say. I always go to FDGL for .shps and other info on Florida, but my study region is FL.
It's hard to navigate the whole UF catalog system anyways
I work the GeoPlan Center and get most of my data from there or Labins?
Map Library is great!

APPENDIX C
SAMPLE SURVEY SHEET

UF Library catalog GEOGRAPHIC searches survey:

To: **ALL Library patrons**, specifically researchers using geographical references
From: Jorge A. Gonzalez, Senior Archivist, Smathers Libraries, University of Florida

This survey is to help find problem areas in searching cartographic library materials for academic research. UF library patrons are involved in study or research that requires use of the library catalog and access to materials of a geographic nature. Your answer to the following survey questions will help identify problems that come up while searching the library catalog. Please be aware you do not have to answer any question you wish not to answer. This survey will take about 2-3 minutes to answer. No payment is offered but your participation is appreciated. There are no risks to you for participating in this study. Your identity will remain anonymous. There are no immediate benefits to the participant, but it is hoped that this survey will help future library users make better searches of a geographic nature or subject. No one under the age of 18 may participate in this program.
*** For questions about your rights as a research participant, contact the IRB office at 392-0433 or irb2@ufl.edu ***

*** Please **circle** all choices in **bold** that apply ***

→ 1. Are you? **Undergrad** **Graduate** **Faculty** **Staff** **Visitor** **Other**

2. While searching the library catalog do you look for (and find or use) any of the following information or formats of publication?

--Census data **--Demographic information** **--Digitized data** **--GIS materials**

--Statistical documents **--Aerial photos** **--Satellite images** **--Other (Atlas, CD's, etc.)**

3. Do you find an adequate amount of materials of a geographical nature in the library database?

Yes **No** **Unsure**

4. Which of the following is your preferred location for searching said materials?

-Main branch **-Other branch** **-Map Library**

-From Home **-From Internet** **-Elsewhere: _____**

5. How do you think library listing (cataloging, or description) of geographic materials can be improved to assure you have done a thorough search of the library catalog to satisfy your needs or requirements or, what can be done to help you get the most out of your search? Providing:

-More geographic headings **-More geographic notes** **-More coordinates (lat/long) info.**

-Acquiring more print maps -Increasing access to staff -Improving geographic literacy

-Other: _____

6. Do you rely on latitude/longitude to help you retrieve cartographic materials?

Yes **No**

7. Would you prefer searching **latitude/longitude** or geographic **placenames** to find maps? Or **both**.

8. What other problems do you generally or specifically encounter when searching the library database for geographic/cartographic materials?

_____

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