# Libraries and GIS Technology

## Introduction

Maps helps us to understand the world around us and how we influence each other. They are one of the visual and spatial components of libraries. Maps help people to think spatially (Elliott, 2016, p. 8). As with many other aspects of life, technology is changing how we interact with and use maps. Developed in the 1960's, Geographic information systems (GIS) change the ability of humans to understand their impact in and on geography. The National Research Council [NRC] stated: "The ability to perform spatial operations on databases and generate graphic output that would be laborious or impossible to do manually (National Research Council [NRC], 2006:163) is a key benefit of GIS" (as cited in Jackson & Kibetu, 2018, p. 203). The ability to combine maps with data increases our ability to understand geospatial relationships and acquire new knowledge.

The library is a "neutral," central location for GIS technology (Elliott, 2014, p. 9). GIS was first used by mainly geologists but is now being used by many different disciplines including: political science, environmental studies, public administration, engineering and more (Houser, 2006, p. 322). Its use will continue to expand, and librarians and information professionals can be part of its future growth. Elliott (2016) wrote that "people are beginning to see how GIS impacts our ability to do things and libraries are responding by expanding GIS services" (p. 8). This paper explains the importance of GIS in libraries and its potential for future use in academic, public, and school libraries.

## Research methods

Academic journals, databases, books and internet sources were used to discover information about GIS. Beginning with academic journal articles, multiple databases were searched to find peer-reviewed research about the use and effect of GIS in libraries and

education. Specifically, the LISGA, ERIC, and GEOBASE databases were searched, along with a generic search performed on University of Missouri library's discovery layer. Search terms for these database queries included: GIS, GIS and public libraries, GIS and school libraries, GIS in K-12 education, and more. Similar terms were searched on Google Scholar to see if other types of information could be found. Additionally, an internet search was performed to find GIS sources on business, industry and government websites. Questions to clarify what GIS services and tools specific libraries offer were answered by reference services at MU library and Mid-Continent Public Library. Inter-library loan (ILL) was used to get access to a book about GIS. After sorting through the information and articles, two more sources were found: a report compiled by NASA and a website for the Federal Geographic Data Committee which controls the standards and information for GIS in the United States.

This paper begins by defining GIS and then gives an overview of how these systems are currently used in libraries and schools. Three different settings of GIS use will be considered: GIS use in academic libraries, GIS use in public libraries, and GIS use in school libraries at the K-12 education level. Included in the discussion of each setting will be the different levels of GIS use and the potential for future use. Next, standards relevant to GIS are presented. The paper concludes with a discussion about GIS in libraries and schools with recommendations and ideas for further study and ways to incorporate GIS into each of these settings.

**Geographic information system or GIS**

A geographic information system or GIS is a computer system that incorporates large amounts of data, spatial information, and maps to view, analyze, and understand the relationships of the data in a geographical space (Martindale, n.d.). Geographic information systems were developed in the 1960's, the first being Canada's CGIS in 1962 (Grinderud, 2017, p.16). GIS incorporates both visual and spatial data, often in the form of a map, with a human component

that allows analysis and projection to understand relationships, view problems and inform decision making (Jackson & Kibetu, 2018, p. 201). This is known as the "The Geographic Advantage" which means that the earth's surface becomes a "laboratory" for a wealth of spatial happenings or hypotheses to "study" (Jackson & Kibetu, 2018, p. 201). National Geographic defined GIS stating: "by relating seemingly unrelated data, GIS can help individuals and organizations better understand spatial patterns and relationships" (GIS, 2017, para. 1).

"A central concept in GIS is layers" or the ability to layer maps and data to understand geospatial and human relationships and how they interact (Elliott, 2016, p. 8). GIS uses three different sets of data: vector, raster, and attribute. Vector and raster model data sets are spatial, with vector showing terrain features and raster showing real images or photography that are identified by pixels (Grinderud, 2017, p. 48; Elliott, 2016, p. 9). Attribute data is descriptive text, for example Excel tables (Elliott, 2016, p. 9). Elliott explains vector and raster data as the "where" or "features" and attribute data as the "what, where and why" that "describe the features" (Elliott, 2016, p. 9). This ability to layer and view spatial relationships and problems makes GIS an invaluable tool in research, education, planning and development.

**GIS use in academic libraries**

Many academic libraries provide GIS services. Three key components of GIS services in academic libraries are: "research, learning, and outreach" (Branch, 2017, p. 418). Academic libraries can help patrons in these areas by providing access to GIS, teaching and training patrons to use GIS for research or learning and informing departments about GIS services through outreach—helping students, educators, and researchers become aware of GIS services the library offers (Elliott, 2016, p. 418). GIS specialists that can train others to use, understand and analyze GIS data sets are crucial to the functionality and effectiveness of GIS services in academic libraries (Holstein, 2015, pp. 46-47).

Offering GIS services will benefit and bolster the research capacity of universities. There are differing types of GIS systems and services offered at academic institutions from ArcGIS to web-based GIS. Academic libraries with "geographic information centers" combine their map collections with newer technology components including "computers, powerful GIS, remote-sensing technologies, GPS services, digital maps, and data" (Holstein, 2015, p. 48). The most prominent high-level GIS academic libraries offer is ArcGIS from ESRI (Elliott, 2016, p. 39). With many different disciplines now using GIS, access to high-level GIS is needed and must be considered carefully due to significant costs of maintaining GIS software and hardware. Fortunately, the ability to provide medium and lower-level GIS technology have improved. These "GIS lite" programs include Google Earth, OpenStreetMap, SimplyMap and more (Elliott, 2016, p. 9). GIS librarians can now enable people with no experience or knowledge to create maps and data for their academic courses and research (Holstein, 2015, p. 48).

GIS librarians can help campus users succeed in learning and applying GIS technology in their disciplines, even in the humanities and social sciences (Branch, Fosmire, & Kong, 2017, p. 413). GIS librarians and specialists train others to use GIS by teaching workshops (Houser, 2006, p. 320). They also teach "spatial thinking, data skills, and tool skills" to GIS users (Branch et al, 2017, p. 418). Librarians can conduct reference interviews and "GIS consultations" to assist researchers with GIS knowledge and resources (Elliot, 2016, p.10; Houser, 2006, pp. 319-320). Libraries provide access to GIS training, knowledgeable staff, and training for multiple levels of GIS use from beginner to advanced (Houser, 2006, p. 323).

GIS librarians can help others understand, learn, and use GIS through outreach. Often people do not use GIS because they are unaware of its availability and the help librarians can offer (Houser, 2006, p. 317). Librarians "increase awareness" about GIS services the library offers (Houser, 2006, p. 324). "GIS is an emerging technology in many disciplines. Introducing

the concept to researchers is critical for them to adopt it in their studies" (Branch et al, 2017, p. 415). A fun, simple way to help others become aware of GIS is by celebrating GIS day. GIS services in academic libraries improve research, help users learn GIS, and promote use of GIS through awareness.

**GIS use in public libraries**

GIS is not widely used in public libraries due to prohibitive costs, but that is changing (Sharma, 2016, para. 3). Due to technological improvements, GIS technologies are becoming more available to public libraries. The internet has increased the ability to use GIS data (Kowal, 2002, p. 110). In recent years, improved metadata and increased geospatial datasets and file sharing by governments, ESRI, and state agencies make accessing and using "geographic research" and "technology" easier (Kowal, 2002, p. 110). The introduction of online "GIS Lite" applications allows users to "combine attribute and spatial data" without needing to know all the highly technical knowledge required of complete GIS (Elliott, 2016, p. 9). According to Kowal (2002), there are three levels of use in public libraries that mimic the use in academic libraries: high-level, midlevel, and low-level (p. 110). Public libraries can help patrons learn about and utilize GIS.

Kowal (2002) highlights examples of high-level, midlevel and low-level GIS use in public libraries and what type of GIS is needed for each. High-level users need expensive GIS technology, both hardware and software (Kowal, 2002, p. 110). This allows the patron to combine collected data with available GIS datasets, government information and maps to create new geographic information (Kowal, 2002, p. 110). Midlevel GIS user's need online "interactive mapping applications" that can utilize GIS datasets and that let users choose different "data and features" to combine in a map format (Kowal, 2002, p. 111). Midlevel use requires high-speed internet access and computer processing capabilities (Kowal, 2002, p. 111). Low-level GIS users

want maps of certain areas (Kowal, 2002, p. 112). The library can assist in helping them locate these maps or geographic photos through website databases, thus, a computer and good internet are required (Kowal, 2002, p. 112). There is great potential for growth of GIS use in public libraries. The public library can help patrons become aware of GIS through outreach and training. GIS provides one more avenue for public libraries to remain a vital part of their communities.

**GIS use in school libraries and K-12 education**

The use of GIS in elementary and secondary education falls behind that of higher academic institutions. In K-12 schools, GIS use is most often taught by teachers, but lack of teacher training and knowledge in GIS limits its use in classrooms (Hong, 2014, pp. 139-140). Teachers recognize that web-based GIS technology would enhance student learning in elementary and secondary education, but also realize their need to be trained in GIS, making it difficult to adopt in the classroom due to the time and materials needed to learn the technology (Hong, 2014, pp. 146-149; Theobald & Vrbancic, 2016, pp. 322-323). Yet, research finds that use of GIS technology in classrooms benefit students by improving academic performance, teaching spatial reasoning, helping develop higher level thinking including “evaluation” and giving experience with “scientific visualization” (Hong, 2014, p. 140; Jackson & Kibetu, 2018, p. 203). For example, in 2010 high school students in Turkey worked on an eighteen-month project using GIS technology to produce a map showing where “disabled pedestrians” could travel safely on sidewalks in Istanbul’s Sisli district (Jackson & Kibetu, 2018, p. 204). This project strengthened students understanding and use of GIS while solving a “social problem” (Jackson & Kibetu, 2018, p. 204). Incorporating more GIS education into K-12 schools would benefit students.

Potentially, school libraries and media centers could enhance classroom adoption and use of GIS technologies. School libraries could begin by providing access to GIS, helping teachers find and learn GIS technology, and promoting the use of GIS in schools. There is a gap in the literature regarding the role of school libraries and media centers in the adoption of GIS use in the classroom. University models of GIS services could serve as a guide in implementing GIS in school libraries and media centers. As GIS becomes more useful to all types of disciplines, school libraries and media centers could play a central role in providing and promoting GIS adoption and use in K-12 education.

**Standards**

Standards relevant to GIS come from different standards organizations to promote the use and interchange of GIS data between companies, organizations, governments, and nations. Standards organizations that create GIS standards include: Open Geospatial Consortium, Inc. (OGC), International Organization for Standardization (ISO), American National Standards Institute (ANSI), International Electrotechnical Commission (IEC), and more. ESRI identified three categories of GIS standards: "data, metadata, and services" (ESRI, 2012, para. 2). Data standards are used to "store or transfer" geographic data in a "common format" (ESRI, 2012, para. 3). Metadata standards are used to "store, organize, manage and share metadata" (ESRI, 2012, para. 4). Services standards allow for the "transfer" or "remote access" of geospatial data on the internet (ESRI, 2012, para. 5). ISO standard Web Map Service (WMS), is an example of a well-used service standard (Grinderud, 2017, p. 67).

In the United States, the Federal Geographic Data Committee (FGDC) works to develop and adopt GIS standards that comport with its National Spatial Data Infrastructure (NSDI) plan (FGDC, 2017b, para. 1). A list of GIS standards is given on the FGDC website and includes standards for GIS data, metadata, and interoperability (FGDC, 2011a) Interoperability standards

deal with GIS data being accessed, used and re-used by other GIS users. Due to its immense collection of data each day, NASA (2005) published research about GIS interoperability and standards to determine if the "reuse" of data sets was profitable and beneficial to the interests of the United States (p. iii). In this study NASA determined that adhering to international standards for GIS was beneficial to the United States (NASA, 2005, p. 45). GIS standards increase the ability of people to understand, use and share geospatial information at lower costs which benefits libraries.

**Conclusion**

The future of GIS and libraries promises to be bright. Academic libraries provide GIS access, awareness, and use to researchers, educators, and students alike. Many universities provide centrally located GIS in their campus libraries while others house GIS in geography departments. The MU library refers people to the geography department but acknowledges that many disciplines use GIS. Future research could seek to prove the benefits of GIS use by all academic disciplines. Could each academic department contribute to maintain GIS to defray costs and collectively support GIS use in academic libraries? It would behoove academic institutions to move GIS to centrally located libraries for all disciplines to use. Academic libraries will continue to promote GIS awareness, provide GIS access and training to improve university education, research, learning, and outreach.

Public libraries can benefit from greater implementation of GIS services. Librarians can become proficient in GIS and then teach and train patrons to use low, mid, and high-level GIS depending on their needs. They can also teach courses and how to use online GIS systems. Public libraries can promote awareness of GIS by participating in GIS day. There is ample potential for growth of GIS use in public libraries.

GIS needs to be more incorporated into K-12 education which has been slow to adopt, integrate and use GIS. School libraries and media centers are an untapped resource to potentially help teachers and educators integrate GIS in K-12 education and classrooms. School librarians could provide access to web-based GIS tools. They could become more adept in GIS and help train teachers to understand and use GIS in their classrooms. They could celebrate and promote GIS day at their schools. Academic libraries could collaborate with K-12 school libraries to help them adopt, learn and promote the use of GIS in schools. GIS would benefit K-12 schools to better prepare our young people for future work.

GIS use is important in academic libraries, public libraries, and K-12 education and there is potential for future use and growth of GIS in libraries and education. GIS librarians are a key component in training others to understand and work with GIS. Understanding and utilizing GIS will improve K-12 education and help young people. As GIS changes the landscape of how we use spatial data, libraries promise to be a vital part of its adoption, use and growth in academic, public, and school libraries.

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