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Library Adoption and Use of GIS as an Information Sharing Tool during the Covid-19 Pandemic

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During the Covid-19 pandemic, libraries closed their physical facilities, offered shorter hours, rearranged and removed furniture, shifted to distance service provision, and used geographic information systems to support information sharing. For several decades, library and information studies has used geographic information systems for multiple purposes, and this occurred more than ever during the Covid-19 pandemic. This research investigated different ways libraries and library agencies have been using geographic information systems to support information and resource sharing during the Covid-19 pandemic. The overarching goal was to demonstrate how libraries provide value to local communities and society. Interview research identified multiple mapping projects undertaken either in relation to or during the Covid-19 pandemic, including maps depicting public access to Wi-Fi Internet, library building status, inter-library loan receiving and sending status of libraries, and library usage data, as well as a state Covid-19 data dashboard. Interviewees reported using geographic information systems for ease of use, interactive data displays, comparing multiple data points, increasing engagement and awareness, tailoring services, and currency of reporting. Now that they have made some maps and seen how helpful the maps are for access, interviewees had many ideas for expansion of new mapping projects going forward.

Keywords: GIS; geographic information systems; libraries; Covid-19; information service provision

Introduction

The outbreak of the SARS-COV-2 virus in late 2019 and resulting Covid-19 pandemic affected every person in every country, including libraries and library services. During the Covid-19 pandemic, libraries closed their physical facilities, offered shorter hours, rearranged and removed furniture, and shifted to distance service provision. Another thing libraries and library agencies (e.g., consortia and state library agencies) did was to use geographic information systems (GIS) to support information sharing during the Covid-19 pandemic.

GIS has been used in library and information studies (LIS) for several decades (Bishop and Mandel 2010; Mandel, Bishop, and Orehek 2020), for multiple purposes, and use of GIS has continued to grow. GIS were defined as "the collection of hardware, software, output devices and practices that are used to analyse and map spatial entities and their relationships" (Schuurman 2009, 277). This broad definition included a wide variety of tools, from products that offer multiple advanced options for storing, analyzing, and displaying data like Esri's ArcGIS to more basic but user-friendly tools like Google My Maps. State Covid-19 data hubs primarily ran on Esri ArcGIS software, and maps of Covid-19 outbreaks were commonplace in the news and on social media. Libraries joined the GIS efforts in a variety of ways. The state of Florida's Covid-19 data hub was run out of the University of South Florida Libraries (Trela 2020). The Montana State Library mapped Covid-19 impacts on libraries in their state (Fashoway 2020; Coronavirus response 2020). The Brooklyn Public Library added Covid-19 impact stories to their oral history project (n.d.). Both Connecticut and Texas used GIS to map library openings and closings in their state; Connecticut used Datawrapper (CT State Library 2020), and Texas used Google My Maps (Texas Library Status Map 2020). OCLC mapped libraries available for interlibrary loan (ILL) services (2020). An academic library in Mississippi mapped parking lot Wi-Fi hotspots across the state (Mississippi University for Women's Fant Memorial Library n.d.), and Georgia Public Library Service mapped public library Wi-Fi hotspots in their state (2020). These were some of the ways that libraries and library agencies adopted GIS as a tool for collecting, storing, analyzing, and visualizing data during the Covid-19 pandemic.

This research investigated different ways libraries and library agencies have been using GIS to support information and resource sharing during the Covid-19 pandemic. One of the key challenges libraries always faced was to demonstrate their

value. Studying and reporting how libraries have used GIS to develop collaborative projects with other libraries, state governments, and academic researchers would demonstrate multiple areas through which libraries provided value, both to local communities and to society.

Literature Review

GIS Use in Libraries

There have been several comprehensive reviews of use of GIS in libraries and library services (Bishop and Mandel 2010; Mandel, Bishop, and Orehek 2020; Sharma 2015). These reviews found that libraries primarily use GIS to analyze data related to service populations (Bishop and Mandel 2010; Mandel, Bishop, and Orehek 2020), to manage library facilities and collections (Bishop and Mandel 2010; Mandel, Bishop, and Orehek 2020), and in support of planning (Sharma 2015). More recent studies have used GIS in library facility siting (Shorabeh et al. 2020), to identify underinvested neighborhoods that could benefit from outreach to foster equitable access (Jackson and Yarbrough 2021; Rosichan 2020), to compare performance indicators across libraries (Esrootchi et al. 2020), and in strategic planning (Jackson and Yarbrough, 2021). Libraries also have used GIS and mapping technology in patron-facing projects. For example, the University of Illinois Springfield's library created a map that would help students find outdoor places to study in nice weather (Rice 2021), and the National Archives of Australia created a map-based search interface for archival records (Belton 2019). Reasons given for using GIS in these studies and projects included the myriad database capabilities of GIS (Shorabeh et al. 2020), to allow patrons to search for records and materials by geography, and to compare multiple data points in support of funding requests (Rosichan 2020) and visualization of geographic patterns in data (Eskrootchi et al. 2020).

GIS has also proved to be a valuable tool in library-based disaster planning and response (Craner 2019). Maps can be created in free tools like Google My Maps to identify and share information with patrons about flood zones to encourage disaster planning (Craner 2019). An academic library in Georgia coordinated an effort to use GIS to identify physical locations of all of Georgia's cultural organizations and create a map that would facilitate quick recovery in response to disasters (Landis et al. 2021). In another project, Ghorbanzadeh et al. (2021) used GIS to compare multiple datasets to determine whether physical library locations were ideal for communities to access in the wake of natural disasters based on the physical location of libraries in terms of access to road networks, travel cost, transportability of different population groups, and other variables. Craner (2019) explained that during and after a disaster, a library could facilitate a crowd mapping project using data collected on Google Forms and then mapped on Google My Maps to identify areas of danger or safety. GIS data were also noted as a rich source of information about the Covid-19 pandemic, with the Library of Congress actively collecting such data for future research, access, and use (Maloney 2021).

Covid-19 and Libraries

The Covid-19 pandemic caused major and sudden changes in library service provision. Libraries were forced to "react, adapt, and improvise" (Tolppanen 2021, 65) to continue providing needed services to their communities while also "safeguarding the welfare of their staff" (Rice 2021, 10). Libraries closed their buildings, reduced their hours, or restricted access to space (ALA 2021; Berra 2021; Jackson and Yarbrough 2021; Rice 2021; Tolppanen 2021). "For libraries, however, closing didn't mean shutting down; rather it required finding new ways to serve and continue supporting their communities--often at a distance" (ALA 2021, 8).

Academic and public libraries implemented curbside or other alternative pickup options to minimize patron-staff interactions (Berra 2021; Jackson and Yarbrough 2021; Tolppanen 2021). Some circulated laptops and hotspots to further support physically distanced, free Internet access for their patrons (ALA 2021; Berra 2021; Real 2021). Others placed hotspots in community centers to increase access (ALA 2021). Many libraries adapted face-to-face programming to online delivery formats, including live streaming events through Zoom and YouTube, and posting recorded events for continued viewing (ALA 2021; Berra 2021; Jackson and Yarbrough 2021; Real 2021; Rice 2021). School and academic libraries supported teachers and students in virtual learning (ALA 2021).

Academic libraries modified returns, checkout, and ILL policies and activities to minimize patron-staff interactions and allow for quarantining of returned materials (Tolppanen 2021). They increased virtual and telephone reference services (ALA 2021). Public libraries created take-home kits and curated selections of books so patrons had hands-on access to library resources (ALA 2021; Real 2021; Rice 2021). Public libraries increased their Wi-Fi range beyond their buildings to allow patrons to access their Wi-Fi from parking lots during times of closure or limited hours and to purposely provide a safe location for free Internet access in their communities (ALA 2021; Berra 2021; Garcia-Ortiz 2021; Real 2021). Some used their bookmobiles to provide Wi-Fi access to areas of the community that otherwise lacked such access (ALA 2021). They also reallocated money from physical to digital materials during times of building closures and implemented more digital services such as online library card signups, virtual reference, and technology help services. Some public libraries even delivered materials directly to patrons at home (Garner et al. 2021). School libraries expanded their services to support parents, teachers, and students in virtual learning (ALA 2021).

They hosted virtual author visits, provided access to and training on technology tools, and supported efforts to identify digital materials for the curriculum.

Library agencies implemented increased communication efforts, such as updated websites with curated resources for service provision during the Covid-19 pandemic, regular briefings or newsletters, and results of surveys that showed which services libraries were providing in this challenging time (Rice 2021). State library agencies also coordinated statewide efforts, such as statewide surveys of library activities during the Covid-19 pandemic (Real 2021).

Research Questions

With an ongoing research agenda to document the myriad uses of GIS for mapping library use and encourage more libraries to use GIS in support of their work, the researcher keenly observed the multiple new library mapping projects that appeared during Spring 2020 lockdowns. This led the researcher to want to understand how and why libraries and library agencies embraced GIS and mapping in a time of enormous stress and upheaval (i.e., the Covid-19 pandemic) in support of the larger goal of wider adoption of GIS in libraries. This interview research was guided by the following research questions:

1. What projects have libraries undertaken during the Covid-19 pandemic that utilized GIS and mapping?
2. Why did libraries undertake these projects in this specific time?
3. Why did libraries choose to use GIS for these projects?

Methods

To ensure the safety of both the researcher and research participants during the ongoing Covid-19 pandemic, this study utilized in-depth qualitative interviews conducted via Zoom. The style of the interview was more of an interaction or conversation than a rigid

quantitative questionnaire would have allowed (Babbie 2012). The research protocol was reviewed and approved by the researcher's Institutional Review Board. Zoom is a technology that facilitated a conversation that was as close to an in-person face-to-face interaction as possible and that allowed the researcher to record the interviews and transcribe them afterward. Transcripts were then coded using narrative analysis (Wiles, Rosenberg, and Kearns 2005). After recordings were transcribed, coded, and analyzed, they were deleted from the researcher's Zoom account on the Zoom Cloud Server.

Sample

In order to interview people with knowledge of the research purpose, the researcher employed a purposive sample. A researcher would use purposive sampling when selecting specific elements of the population for specific reasons (Babbie 2012). That was the case here since the interviewees were the people responsible for the projects identified in the literature as within the scope of the research purpose.

The researcher also identified further subjects through snowball sampling. The last question in the interview schedule asked participants if they knew of any other people working with GIS in libraries or library agencies as an information tool in the Covid-19 pandemic. Those other users of GIS in libraries and library agencies were then contacted to see if they were willing to participate in the research project. Ultimately, eight interviews were conducted until the researcher had reached saturation, or the point at which no new information about how or why libraries and library agencies had employed GIS during the Covid-19 pandemic was being collected (one interview included two interviewees, so nine total people were interviewed).

Interview Schedule

Each interview began with a review, discussion, and signing of the Informed Consent document. In-depth qualitative interviews were guided by the following interview schedule:

- What educational background (if any) do you have in GIS?
- How have you used GIS in your library work prior to Covid-19?
- What projects have you been doing in your library work using GIS during Covid-19?
- Why are you using GIS for these projects?
- How do you think these projects will continue, adapt, or expand after the Covid-19 pandemic ends?
- Are there other projects you plan to undertake in your library that use GIS? Please describe.
- What are your overall views on library use of GIS?
- Is there anything else you would like to add?
- Do you know of any other librarian or librarians who are using GIS in their library work during Covid-19?

Confidentiality

The interview responses included descriptions of the participants' current and prior work using GIS in libraries and participants' personal views on the uses of GIS in libraries. Although this paper intentionally does not identify libraries or library agencies by name, because of the nature of the field and the relatively small number of GIS projects that are completed in libraries, it is impossible to keep the libraries from being identified entirely. Each project is unique enough that readers of the research might be able to identify which library matches with the project being described. Interviewees' personal views are strictly confidential. Participant names were removed from the

transcripts of the interviews and all data on librarians' views of uses of GIS in libraries is being reported in the aggregate.

Results

Eight interviews were conducted with nine representatives of seven different projects. Two interviews were with representatives from one statewide mapping project, and one interview included two people from the same project who were interviewed concurrently. Interviewees represented GIS mapping projects implemented at an academic library (in partnership with community organizations), one library consortium, four state library agencies, and one grassroots project.

Background in GIS

None of the people interviewed who represented Covid-19 pandemic-era GIS projects in libraries had any degrees in geography, cartography, or GIS. One had attended multiple professional development trainings from ESRI, two others had attended professional training in GIS or been taught one-on-one by a GIS expert, and three were self-taught. Three had no background or training in GIS at all.

GIS-enabled Projects

Prior to Covid-19, three of the interviewees noted that they and their libraries had not used GIS for any projects (two from academic libraries and one from a library consortium). The state library agencies (SLAs) were doing the most work with GIS prior to Covid-19. One SLA had used multiple maps to show the impact of their agency's work, mapped library services from Public Library Survey (PLS) data, and created a map showing usage of their services. Another SLA had maps on Internet speed data at public libraries across the state, a map of library services from PLS data, and a map showing usage of their services. A third SLA had maps of directions to public libraries across the state, a map of public libraries in the state with makerspaces,

and a map of public libraries in the state using the statewide integrated library system. The fourth SLA had created maps of users of their services and of library funding by state legislative districts. One representative from the library consortium reported having used GIS to manage internet protocol (IP) addresses in troubleshooting, and the representative for the grassroots project (who currently works for a professional development organization) had used GIS as a communications tool and to demonstrate to k-12 teachers how they could use GIS in school curricula.

Several interviewees discussed multiple GIS mapping projects undertaken either in relation to or during the Covid-19 pandemic. These projects primarily focused on public access to Wi-Fi Internet (Table 1). Three of the Wi-Fi maps were run by SLAs, and two were run by academic libraries. Two of the maps depicting library building status (e.g., open, closed, hybrid) were run by SLAs, and one was a national project undertaken as a grassroots effort.

Table 1. GIS mapping projects undertaken during the Covid-19 pandemic.

Categories of mapping projects (alphabetical)	**n**
geotagging archival documents	1
library building status	3
library ILL status	1
library usage data	1
state Covid-19 data dashboard	1
wi-fi access points	5

Interviewees had many ideas for expanding and updating existing GIS-enabled projects or for new GIS-enabled projects. All interviewees had multiple ideas. The most popular ideas were to add variables to existing maps or to map library usage data (Table 2). Two people were unsure what they might do in the future with GIS, and three thought the Covid-19 pandemic-era mapping projects would be discontinued or

archived. The representative who had been trained one-on-one from the state GIS coordinator (who also works within the SLA) had the largest number of ideas (n=8).

Table 2. Interviewees' ideas for future GIS-enabled projects.

Categories of future ideas (alphabetical)	**n**
adding questions to PLS to annually update existing maps	1
adding variables to existing maps	3
archived map project	1
digital humanities map projects	2
discontinue	2
library building status during disasters	1
library usage data	3
locations by service provision	1
on demand mapping	1
pickup location maps	2
switch GIS platform for existing project	1
target funding	1
target marketing	1
time lapse map of pandemic	1
transfer map project to another department	1
unsure	2

Reasons for Using GIS

The most popular reasons for using GIS for library projects were for ease of use and interactive displays of data (Table 3). One interviewee noted that GIS "helps people make those visual connections," especially in comparison to lists or spreadsheets. Another interviewee reported that spreadsheets are boring for many people whereas maps "are really accessible for the layperson to understand."

Table 3. Reasons given for using GIS in library projects.

Categories of reasons (alphabetical)	**n**
ability to do it	1
compare data points	4
control information overload	1
currency	2

ease of use	6
finding physical locations	1
increase engagement and awareness	3
interactive data selection	6
promotion of library services	1
tailor services	2

All interviewees reported positive views of GIS use in libraries. Six reported only positive views, one reported a mix of positive and neutral views, and two reported a mix of positive and negative views. The negative views related entirely to the challenges for library adoption of GIS: prohibitive cost and difficulty in learning to use GIS products. Positive views of GIS included that it expands access to and use of data, is useful for decision making, offers new avenues for research, and that it enables valuable visualizations of data (Table 4). One interviewee said of GIS, “it's a great way to expand usability and accessibility” of data and information. Another interviewee also noted that GIS is “really a natural fit [for libraries] because…we do an awful lot of visualizing data anyways.”

Table 4. Interviewees’ positive views of GIS use in libraries.

Categories of positive views (alphabetical)	**n**
expands access to and use of data	2
expensive and not user-friendly	3
for decision making	4
general positive comment	4
importance of data literacy	1
mandatory aspect of services in today's world	3
new avenues for research	1
train the trainer to reach end users	1
value of visualizing data	6

Software in Use

Most libraries and library agencies were using multiple software products, either because they started with one and switched to something with greater capabilities or because they used different software for different project purposes. The most frequently used GIS products were Google products: Google Maps (2022), Google My Maps (n.d.), and Google Forms (n.d.); these were used in five of the libraries and library agencies. The next most frequently used products were Esri products, used in three agencies: ArcGIS (n.d.) and Survey123 (ArcGIS Survey123 n.d.). Two agencies were using Tableau (2022), one was using Datawrapper (Kokkelink et al. 2021), and one was using Adobe Photoshop (n.d.).

Discussion

Strengths and Weaknesses of the Method

Using qualitative interviews is a flexible method that can elicit rich data from each interviewee. The main weakness of the study is that there is limited generalizability due to the inability to conduct statistical analysis of a large population. However, this method is often considered more valid for descriptive research than quantitative methods, due to the detailed descriptions that are elicited.

Library Uses of GIS During Covid-19 Pandemic as Compared to Pre-Pandemic

Before the Covid-19 pandemic, the literature shows that libraries were using GIS to analyze service area populations, manage library facilities and services, and as a planning and assessment tool. None of the people interviewed for this project described using GIS to analyze service area populations prior to the Covid-19 pandemic. Several of the pre-pandemic GIS-enabled projects were to analyze and manage library facilities and services: one map of Internet speed data, four maps of usage data, and the use of IP addresses in troubleshooting consortia services. New categories that are not represented in the prior literature but that emerged from this study are using GIS to communicate

and display impact and value, teaching others to use GIS, providing directions to physical locations, and customer service.

Most of the GIS-enabled projects undertaken during the Covid-19 pandemic fit into categories previously identified in the literature. The library building status maps, ILL status map, and usage data map all fit into manage library facilities and services, as described by Bishop and Mandel (2010), Mandel, Bishop, and Orehek (2020), and Sharma (2015). The state Covid-19 data dashboard could be considered a planning and assessment tool as described by Sharma. The project that involved geo-tagging of archival documents represents a new category of use of GIS in libraries not previously described in the literature. So do the Wi-Fi access point maps. These maps were designed for customer service purposes, not for analyzing populations, managing services, or planning and assessment.

The previous literature by Bishop and Mandel (2010) and Mandel, Bishop, and Orehek (2020) was focused on use of GIS in library *research*. Most of the projects described by the interviewees in this study were not for the purpose of research. Using GIS to communicate and display impact, for example, is about using GIS as a tool of persuasion, not a research tool. Teaching others to use GIS is about using GIS in the instructional role of librarians, not research. Providing directions to physical locations and statewide Wi-Fi access point maps are about customer service, not research.

Usage of GIS as a tool of customer service appears to be a growing area for use of GIS in libraries and library agencies. Some of the ideas for future use of GIS as a customer service tool were to map libraries based on which ILL services they provide so users can see at a glance who is doing what, maps of pickup locations, and GIS-enabled apps to help time pickups (similar to commercial services offered by companies like Target).

Geo-tagging archival documents is also a category of use of GIS in library research not previously described in the literature. It is also a purpose that was mentioned as a possible future use of GIS among interviewees. Other digital humanities mapping projects in libraries are on the horizon.

Barriers to Using GIS

The state Covid-19 data dashboard was run out of a state library agency that houses the state's GIS shop under the SLA umbrella. That particular SLA created the state Covid-19 data dashboard, a Wi-Fi access points map, a library usage data map, and a library building status map. When asked why they used GIS for these projects, the representative said, "I think a big reason is we can. We have the luxury of having all these tools already, so, um, it's pretty simple for us to put them into play." This makes sense since other library representatives noted that lack of expertise was a major barrier to their use of GIS prior to, during, and after the Covid-19 shutdowns. This is also a common thread in the literature cited above. Pournaghi and Babalhavaeji (2015) reported that academic libraries were best positioned to utilize GIS as a tool due to access to resources and expertise, but this study found that both academic libraries and state library agencies are strong candidates for using GIS.

Google products seemed especially easy for libraries and library agencies to use. One interviewee reported that Google products were used "to get the information out there as quickly as possible, and in a visual and easy to understand format," especially since many people are already familiar with Google Maps. Another said of GIS in general, "I think it's so useful for libraries. I wish more were using it," but the barriers to entry are substantial. They acknowledged that individual libraries need to be given tools to use GIS, including access to both software and training on how to use GIS "because at first it's really intimidating."

The interviewees with no GIS background at all were using Google products, likely due to perceptions of user friendliness of the interface and prior personal experience using Google Maps for directions. One who is self-taught mentioned they stick to software with "low barrier to entry." Google Maps is a valuable tool for other reasons. Patrons are most likely already familiar with Google Maps. Also, the free Google map-creating tool, Google My Maps, "makes it amazingly easy to create, annotate, and share customized maps" (Mallon et al. 2019, 226). Mallon also noted that Tableau Public as another free tool that does not require any specialized skills to use, but all maps created in this tool are public. This was used by two of the libraries in this case study. The more expensive Esri products that were perceived as being more difficult to learn to use were only in use at two state library agencies and the professional development organization.

Where Libraries May Go in the Future with GIS

The literature showed that there has been increased use of online map tools among non-GIS experts in libraries. One interviewee reported that they intended to keep encouraging people to use maps for projects because "a list of libraries is fine, but if we do it visually, you know across a map, it's got a lot more impact." Some saw the potential for increased use of GIS post-pandemic, noting "we may be getting more into mapping and GIS as a result of Covid." After they had tried some maps, they saw the maps were helpful for access.

Interviewees had many ideas for expanding their Covid-19 mapping projects or for new mapping projects. The Public Library Survey administered annually by each SLA already collected address data, and one SLA wanted to add questions that could be mapped annually. Several mentioned mapping usage data, which could be done at the statewide level using the PLS data. There were ideas for digital humanities mapping

projects in archives, maps of pickup locations, and a time-lapse map of Covid-19 pandemic effects on service provision. One interviewee suggested that maps could be used to target marketing efforts and funding; this aligns with Sharma's argument for GIS as a beneficial tool in strategic planning.

Mandel, Bishop, and Orehek (2020) suggested that a way for libraries to use GIS more often would be for libraries to collaborate with GIS experts. One of the libraries represented in this study was doing that: a state library agency in which the state GIS coordinator was housed. Not surprisingly, that was the library agency doing the most mapping of any agency included in this study, and it was the library agency that had the most ideas for future GIS-enabled projects. This level of collaboration (i.e., housing the state GIS coordinator in the library agency) might not be attainable for all libraries, but collaborating with city/county GIS departments and GIS researchers at universities could be within the reach of most librarians.

Conclusion

GIS is a valuable tool for collecting, storing, analyzing, and visualizing library data. There was already a history of libraries using GIS in support of their research endeavors prior to the Covid-19 pandemic. At one time, creating maps was the rarified work of specialized cartographers, but now that user-friendly and inexpensive mapping software have become available, anyone could easily create and share a map online. While the Covid-19 pandemic brought on many challenges for libraries (and everyone else), it also led to creative solutions for service provision at a distance. One such solution was the use of GIS and mapping as tools that could support information service provision at a distance. The future of GIS use in libraries and library agencies looks bright, since people who have used GIS once and seen the value it added to data analysis and information sharing would be likely to return to it again and again.

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