Open geospatial data: A comparison of data cultures in local government

Karen Majewicz[1], Jaime Martindale[2], Melinda Kernik[3]

Abstract

Public geospatial data (geodata) is created at all levels of government, including federal, state, and local (county and municipal). Local governments, in particular, are critical sources of geodata because they produce foundational datasets, such as parcels, road centerlines, address points, land use, and elevation. These datasets are sought after by other public agencies for aggregation into state and national frameworks, by researchers for analysis, and by cartographers to serve as base map layers. Despite the importance of this data, policies about whether it is free and open to the public vary from place to place. As a result, some regions offer hundreds of free and open datasets to the public, while their neighbors may have zero, preferring to restrict them due to privacy, economic, or legal concerns.

Minnesota relies on an approach that allows counties to choose for themselves if their geodata is free and open. By contrast, its neighboring state of Wisconsin has passed legislation requiring that specific foundational geospatial datasets created by counties must be freely available to the public. This paper compares the implications and outcomes of these diverging data cultures.

Keywords

Geospatial data, geodata, GIS, open data, local government, Minnesota, Wisconsin

Acknowledgment

Thank you to Yijing Zhou for research assistance and cartography.[4]

1. Introduction

Two of the authors, both of whom work at the University of Minnesota's John R. Borchert Map Library, heard the following exasperated question at a recent Geographic Information Science (GIS) professional conference in Minnesota: 'Why am I able to download a free and open statewide parcel dataset that includes every county in Wisconsin, but not in Minnesota?' There was a noticeable whiff of envy in the room. 'Free and Open Data' across Minnesota's state and local government has been the stated top priority for the assembled community for the past four years, while Wisconsin cleared the hurdle seemingly overnight. What differences in the communities of practice in Wisconsin and Minnesota led to this uneven landscape?

To answer this question, we partnered with our colleague at the University of Wisconsin-Madison's Robinson Map Library to delve into each state's GIS history, programs, organizations, and legislation to construct a comparison of our respective open geospatial data (geodata) landscapes. Our case studies revealed that (1) legislation, (2) funding models, (3) workflows for contributing to the state's primary geodata platform, and (4) the involvement of libraries are key differences in the divergent outcomes.

2. Overview of open geodata

2.1 Qualifications

For the purposes of this article, geodata encompasses vector (points, lines, polygons), raster (i.e., lidar DEMs, orthoimagery, landcover), and database files that contain spatial information. To qualify as 'open geodata,' we have identified three criteria. First, the data should have an open license or open status. This means that users cannot be required to sign a license, sharing the data cannot be restricted, and the data

does not contain confidential or private information. Second, the data should be accessible for free, without even minimal charges. Third, the data should be downloadable as discrete layers and not just viewable from inside an online web map or database application.

For context, in Figure 1, we have compared our criteria against two other models: the Open Knowledge Foundation's (OKF) 'Open Definition 2.1 of Open Works' and Daniel Sui's article, 'Opportunities and Impediments for Open GIS' (Open Knowledge Foundation, n.d.; Sui, 2014). We chose these models because the OKF criteria are widely cited for general open data, while Sui's is specific to geodata.

Required criteria	Our model	OKF Open Definition 2.1	Sui (2014)
Open License or Status	X	X	X
Free	X	[reasonable fee]	X
Downloadable	X	[recommended]	
Open, non-proprietary format		X	
Usable: Features quality data and metadata			X

Figure 1. A comparison of open data qualification criteria models

Some aspects of the compared models are more lenient than ours. The OKF model allows data providers to charge a fee. Although they do mitigate the severity of this with the phrase 'no more than a reasonable one-time reproduction cost,' this practice has the potential to function as a kind of loophole. For example, our Minnesota case study will observe that, although all government data is defined as 'public' by state law, counties and municipalities are still allowed to charge fees to cover the cost of assembling and sharing their geodata. Consequently, this practice has effectively prevented geodata from being findable and accessible across a large part of the state.

Another tolerance that we disagree with is that neither the Sui nor the OKF models specify that datasets must be downloadable. Unfortunately, this is a common constraint on geodata due to the prevalence of web maps, which enable users to view and interact with a preselected set of layers, but typically prohibit dataset downloads. Maas (2019) describes this kind of data as 'captive,' meaning it cannot be analyzed or mapped outside of the application's restricted scope. Despite this limitation, government agencies have been publishing web maps ever since The National Atlas of Canada went online in 1994 (Kramers, 2008), and there is a perception that they fulfill the ethos of open geodata. We concede that web maps have played a role in increasing public interest in the utility and value of geodata, as users can consume geospatial information without needing to be well-versed in the complexities of GIS formats, structures, or technology. However, there is now a wide array of new and emerging user-friendly mapping tools that

have reduced barriers to the public's ability to collect, merge, and analyze geospatial content from different sources. As a result, a closed web map excessively limits what users can do with its data.

Other aspects of the compared models feature stricter criteria than ours, and we acknowledge that these represent worthy goals. However, the current nature of GIS technology would make those criteria challenging to meet. For example, OKF specifies that to be considered "open," datasets should be available in an open-source format. We agree that open-source formats are ideal but contend that in practice the situation is complicated. Some of the most commonly used geospatial file formats are proprietary but still can be read and edited within open-source software. For example, shapefiles are "proprietary but open," with a technical specification published in 1998 (Library of Congress, 2021). File geodatabases are also proprietary but can be used within open-source software using community-developed plug-ins. Because of this, we felt requiring open file formats would be too restrictive and chose not to include it as one of the criteria in our review.

A second condition that we have chosen to permit is data with minimal metadata. Sui proposes that open data must be well described and understandable. When assessing whether a dataset's documentation is sufficient, it is relevant to note that many geodata delivery platforms do not support an intuitive metadata workflow. Publishing to an online portal often involves an automated transformation from a comprehensive metadata standard to a reduced set of core fields, thereby limiting the granularity and possibly corrupting the integrity of the original metadata. We see this as essentially a technological issue that should not disqualify items from being considered open.

2.2 Sources

Public geodata is created at all levels of government. Federal agencies issue the most public geodata. Some of the most well-known examples are satellite imagery from the United States Geological Survey, real-time weather services from the National Oceanic and Atmospheric Division, and demographic information from the Census Bureau. Most U.S. states maintain foundational geospatial layers, such as transportation networks, elevation, hydrography, aerial imagery, and cadastral information. Regional organizations may produce unique sets of resources, such as watershed district boundaries or regional transit systems. Counties are typically responsible for maintaining records of tax parcels, address points, and roads. Municipalities will generally provide important society data, for instance, city services, neighborhood boundaries, local transit, and community centers.

Open geodata is provided through a variety of platforms and technologies. The simplest method, typically utilized by smaller organizations, is to publish datasets as direct downloads hosted on an FTP server or static web page. Larger cities or regions may choose to use dedicated data search portals, such as the open-source Comprehensive Knowledge Archive Network (CKAN)[5] or the proprietary Socrata.[6] These applications are designed for general data and can incorporate tabular data, databases, and spatial formats. Organizations with a sizable amount of geodata may opt for a dedicated geospatial portal application, such as ArcGIS Hub[7] or GeoBlacklight.[8] These specialized applications feature integrated map searches and previews of geospatial web services, which allow users to examine and query the data from within the portal interface without necessitating downloading the data and opening it in a desktop GIS application.

2.3 Availability and barriers

The public availability of open geodata depends upon the administration level that provides it. In the United States, all federally produced geodata (except sensitive data restricted for privacy or security) has been open since 2009 (Blatt, 2016). However, policies about the openness of state and local government

data vary from place to place. Many states have open data initiatives, and the majority maintain an online clearinghouse that provides geodata produced by state agencies (National States Geographic Information Council, 2019). However, most counties and municipalities are not required to comply with either federal rules or state initiatives for open data. As a result, some regions offer hundreds of free open data layers to the public, while their neighbors may have zero. Even when the data is legally declared 'public,' a common scenario is that it is not free or accessible online. In those cases, a user must place a data request with the organization and pay a fee. A GIS professional then manually prepares and shares the datasets via a hard drive or a file transfer.

Many studies have investigated why governments may choose not to share their data online freely. Johnson et al. (2017) questioned the purported benefits of open data and argued that it is unduly costly. For instance, GIS staff would need to implement technology platforms, and they could be subject to an increased workload to maintain and regularly update data. On the other hand, some research disproves the idea that governments would lose revenue. Joffe (2003) and Maas (2013) contended that embracing open data saves organizations money in the long run by reducing staff workload, as they do not need to fill as many specialized data requests. Tombs (2005) described the inclination to keep geodata restricted for public safety and security, but he argued that this practice conflicts with the citizenry's right to public data access and free speech.

Overall, the reasons offered against open geodata can be characterized as apprehension about the potential for negative consequences. Wirtz et al. (2016) identified general risk aversion among public servants as the main barrier. This assessment aligns with a 2016 survey of GIS staff in 59 Minnesota counties that revealed four top issues of concern (Minnesota Geospatial Advisory Council Outreach Committee, 2016):

1. The potential loss of revenue from the sale of geospatial data
2. Legal liability
3. 'Bad Actors' misusing the data
4. Privacy and security concerns

When local governments have the authority to choose whether or not to make their data free and open, many will err on the side of caution. Unfortunately, the resulting lack of contiguous availability thwarts worthy data aggregation efforts and results in increased costs as organizations that need statewide or regional data must either purchase it or recreate it.

2.4 How local open geodata supports the national landscape

Geodata produced by local governments may be foremost intended for use within that administration's local domain. However, many aspects of our environment (e.g., climate and pollution) or infrastructure (e.g., transportation networks) do not terminate at administrative borders. County data layers can be collected, stitched together into statewide layers, and subsequently combined for national frameworks. When geographically adjacent datasets are merged, their value is enhanced by serving expanded areas to inform higher decision-making organizations. This concept has been promoted by national organizations for several projects over the years, including the National Spatial Data Infrastructure (NSDI), the National Parcel Database, and Next Generation 9-1-1.

In 1994, the Clinton Administration tasked the Federal Geographic Data Committee (FGDC) with the advancement of the National Spatial Data Infrastructure (NSDI) (Federal Geographic Data Committee, 1994). The main outcome of the NSDI was to be a set of 'framework' data layers that would form the core

of the infrastructure (Federal Geographic Data Committee, 1997). Tulloch and Fuld (2001) analyzed a late 1990s survey of county-level data producers that revealed several challenges to this project. Of the respondents, 24% did not create any of the framework layers, and even fewer (approximately 10%) maintained any metadata for the layers. Furthermore, data sharing policies were ambiguous or absent. Harvey and Tulloch (2006) followed up five years later to report that the NSDI had improved the standardization and sharing of federally produced data. However, it was still hampered by participation from local governments.

The scholarship on local participation towards the NSDI has fallen off in recent years, but the program received a symbolic boost with the passage of the Geospatial Data Act in 2018. This act was intended to facilitate the NSDI but unfortunately provided no avenues for funding GIS departments. Interviews with the National States Geographic Information Council leaders indicate that state GIS infrastructures are simply not coordinated enough to participate in the NSDI and likely will never be unless federal funding is provided (Wood, 2020).

An essential part of the NSDI would be a national layer of parcels (sometimes referred to as 'tax parcels'). Parcels are land records that define ownership and boundaries, and they are utilized for many purposes, including land use studies, zoning, taxes, and base maps. Except for federal and state-owned lands, individual counties are responsible for creating and maintaining all parcels. Having each county create these records independently has led to wide variations between the formats, attributes, and quality. Although merging these records would be a massive undertaking, a standardized dataset of all the parcels in the country would have many applications, from facilitating land transfers, to assessing public health needs, to coordinating disaster relief.

To get a sense of the difficulty of aggregating all the parcels in the country, consider the relative lack of progress despite long-standing promotion efforts. For example, The National Research Council issued a guidebook in 1980, in which they provided a template for land records to be digitized, standardized, and combined (National Research Council, 1980). This process is known as land records modernization. The Council followed up twenty-seven years later with a report that lamented how much more work was still needed to create a national layer (National Research Council, 2007). This goal was reinvigorated in 2010 when the US Department of Housing and Urban Development (HUD) began a national parcel database project. HUD spent a few years evaluating parcel records from over 100 counties. They discovered that the datasets did not have comprehensive metadata and the data models were so incongruous that standardizing them would be complicated and expensive. They further noted that the scope of merely pursuing data-sharing agreements with the counties was daunting. (U.S. Department of Housing and Urban Development, 2013). This project's current status is unclear, but it appears to be no longer active (HUD Librarian, personal communication, March 11, 2020).

A more recent data aggregation effort that may have a higher chance of success is the Next Generation 9-1-1 project, a national initiative to improve emergency services to rural areas by creating a complete national GIS framework of road centerlines, address points, and administrative boundaries (National Emergency Number Association, 2020). Without accurate GIS data in rural areas, emergency responders are unable to navigate to their destinations efficiently. Unlike other aggregation projects, counties may be more motivated to participate in this initiative, as they will be the direct recipients of benefits that improve the safety of their residents. However, it suffers from the same challenges of coordinating and providing local governments with the resources needed to collect, standardize, and share their data (Kemp, 2017).

3. Case Studies

The following case studies show that the two neighboring states of Minnesota and Wisconsin share several similarities in their open geodata ecosystems. They both have a long history of supporting GIS technology, backed by prominent universities with nationally renowned geography departments and map libraries. They both also have well-supported geodata platforms that can incorporate resources from state, county, and city agencies, as well as nonprofit, business, and educational organizations. However, their stories diverge when it comes to their efforts around local geodata aggregation and availability.

3.1 Case study I: Minnesota

The geospatial community in Minnesota has long supported a climate of innovativeness and collaboration that has resulted in a well-established spatial data infrastructure, particularly for state agencies and the Twin Cities Metropolitan region.

Minnesota was an early hotbed for GIS development and coordinated data management endeavors. The Minnesota Land Management Information System (MLMIS) at the University of Minnesota began in 1967 and was one of the first geographic information systems in the world. Its mission was to inform land use decisions by maintaining a framework of 19 data layers that could be digitally combined, analyzed, and mapped (University of Minnesota, 1976). MLMIS is distinct from other pioneering GIS projects in that it continued for over a decade and is a direct ancestor to the official state geospatial agency in Minnesota today. In the late 1970s, MLMIS was transferred to the Minnesota State Planning Agency as the Land Management Information Center (LMIC). LMIC represented an evolution from a research project into a government-run data services center (Warnecke, 1992), and it operated for over 30 years. LMIC also hosted a search portal, the Minnesota Geospatial Data Clearinghouse, that federated GIS data from multiple sources.

During LMIC's time, other organizations continued developing their own GIS programs. Several state agencies, such as the Pollution Control Agency and the Department of Transportation, developed in-house strategies for creating and managing their own GIS data. The Minnesota Department of Natural Resources (DNR) even built its own open data clearinghouse, the DNR Data Deli.[9] MetroGIS was established in 1996 as a regional initiative serving the Twin Cities metropolitan area, and it also maintained its own open data portal for many years, the MetroGIS DataFinder.[10]

In order to facilitate sharing these collections of open data, the state adopted a custom metadata guideline in 1998. The Minnesota Geospatial Metadata Guidelines (MGMG) is a streamlined version of the Federal Geographic Data Committee's Content Standard for Digital Geospatial Metadata (FGDC). Endorsing this guideline was a progressive and forward-thinking step, as most states do not have an official geospatial metadata profile to this day. (Minnesota Governor's Council on Geographic Information, 1998).

As geospatial technology was flourishing in Minnesota, GIS professionals began to become concerned about a lack of centralization. LMIC was constrained to being an on-demand service organization and, although it acted as the 'unofficial statewide geospatial coordinator,' it did not have the power to implement a statewide infrastructure (Arbeit et al., 2004; Terner et al., 2009). The Governor's Council on Geographic Information was established in 1991 to fill this gap by advising state agencies on GIS activities and data sharing. One of the Council's final initiatives was to create a plan for a more authoritative state geospatial agency run by a geospatial information officer (Minnesota Governor's Council on Geographic Information, 2009). LMIC was then reorganized as the Minnesota Geospatial Information Office (MnGeo),

which operates today as the official state GIS coordinating agency. This action also dissolved the Governor's Council on Geographic Information, which was replaced by the Minnesota Geospatial Advisory Council (GAC).

Minnesota has legislation defining public data as open, but it does not require that it must be free. The Minnesota Data Practices Act, enacted in 1974, designates all data produced by government entities as open, with the exception of confidential or otherwise non-public information. (Minnesota Government Data Practices Act, 1974). This act was established before the age of digital data and was designed for people to visit a local government record keeper and inspect physical sheets of data at no charge (Maas, 2019). Since 1974, the act has been updated and amended many times, often to address privacy issues and to clarify what types of data should be kept confidential. A notable update occurred in 1990, granting counties and municipalities the right to 'charge a reasonable fee for the information in addition to the costs of making and certifying the copies' for digital data (Minnesota Government Data Practices Act, 1990). This update resulted from the enormous expense counties and cities were shouldering to implement computer systems and technicians to collect, transform, and deliver digital data. Maas (2019) notes that the eligible data is still technically public, but it is not guaranteed to be free. This distinction is evidenced by a lack of statewide foundational datasets aggregated from county layers, such as parcels or address points. MnGeo does collect these layers from every county for internal use for projects like Next Generation 9-1-1. While it can share the datasets with other government agencies, it does not make them freely open to the general public because of licensing agreements with the counties.

The GAC is the state's most prominent champion of open geodata. This is evidenced by their annual list of top priorities, which is generated by weighing a variety of factors, including community votes and the likelihood of success. The 'promotion of free and open data' has been at the top of this annual list for each of the past four years (2018-2021). This priority has also shown itself in the GAC's committees and workgroups: the GAC Outreach Committee has made free and open data the main focus of their recent activities, and a newly formed workgroup is exploring strategies for increasing the number of counties with free and open parcel data. In 2021, the GAC evolved further on this issue and upgraded the promotion of free and open data from a 'priority' to a 'guiding principle' that all committees should incorporate into their work.

One of the most successful manifestations of the GAC's open data advocacy has been the development of the Minnesota Geospatial Commons[11] ('Commons'), a collectively managed state platform for open geodata that, as of February 2021, contains 900 resources contributed by 45 different organizations. When the Commons went online in 2015, it replaced multiple state and regional portals, including the aforementioned Minnesota Geospatial Data Clearinghouse, DNR Data Deli, and MetroGIS DataFinder. The Commons accepts data from any public organization, but the primary contributors thus far are state departments and agencies. Resources in the Commons are well-documented because they must be described with the state metadata guidelines, MGMG. The Commons uses a self-service model whereby each contributor has full management over their resources.

The state's advocacy of open government has not brought about a culture of open data in all parts of the state. As of the most recent update in September 2021, only 45 out of 87 Minnesota counties offer downloadable geodata for free (Minnesota Geospatial Information Office, 2021). Furthermore, only ten of these counties have taken advantage of the Commons as a platform to deliver their resources to a broader audience.

Although the availability of county-level open geodata across the entire state paints a patchy picture, the situation in the Twin Cities metropolitan area is quite different. Under the coordination of MetroGIS, each of the seven counties in the metropolitan area has declared open geodata policies. They uniformly share datasets for parcels, road centerlines, address points, parks, and trails & bikeways. The success of MetroGIS can be attributed to the region's history of cooperation and regional policymaking. Although participation in MetroGIS is voluntary, it is administered and financially supported by the Metropolitan Council. The Council was established in 1967 and is still one of the only regional government entities in the country with the power to create policy and provide services, including public transit, wastewater treatment, and land use planning for a multi-county region. Consequently, these counties can rely on long-established networks of working together and complying with decisions made as a group. MetroGIS also advocates for open geodata across the rest of the state and has maintained a web page of open data resources[12] since 2013.

The John R. Borchert Map Library at the University of Minnesota has spearheaded several projects contributing to Minnesota's open data landscape. It developed and hosts one of the most widely used resources in the Minnesota geospatial community, the Minnesota Historical Aerial Photographs Online (MHAPO)[13] website, which provides discovery and access to aerial images dating back as far as 1923. This site features a map interface for finding over 100,000 images that were contributed from a variety of sources, including library holdings, the DNR, and the city of Minneapolis (McAuliffe et al., 2017). MHAPO was awarded the Minnesota Governor's Geospatial Commendation in 2018, which was accompanied by numerous testimonials of its usefulness (Minnesota Geospatial Advisory Council, 2018). The Borchert Map Library is also the project lead for the Big Ten Academic Alliance (BTAA) Geoportal.[14] This is a collaboration of thirteen universities in ten states to aggregate metadata records for geospatial resources and provides access to them through a collective geoportal. Since the BTAA Geoportal indexes metadata from state, regional, county, and municipal geodata portals, it fills a gap in Minnesota's open data landscape. Although the Commons does provide links to externally hosted county portals, the BTAA Geoportal takes it a step further to index each dataset layer and enrich the metadata with normalized place names, subjects, categories, and dates.

Lastly, several staff members from the Borchert Map Library are leading efforts to implement a statewide archive for all public geodata. This has taken the form of multiple workgroups made up of members from the library; state, county, and municipal government; nonprofit and commercial sectors; and the Minnesota Historical Society. This project has been many years in the making (Dyke et al., 2016) and has a wide swath of support across the geospatial community, ranking third on the GAC's list of priorities for 2020.

3.2 Case study II: Wisconsin

Wisconsin's dedication to geodata creation across all levels of government has been a long-standing tradition for over 30 years, during which time there has been a steady series of changes in how geodata has been made available to the public.

The Wisconsin Land Records Committee was established in 1985 to pave a path forward for modernizing land records. This committee developed the Wisconsin Land Information Program (WLIP) to address several needs, including creating standardized data guidelines, reducing inefficient duplications of effort, saving public money, and keeping up with technology advancements, such as geographic information systems (Wisconsin Land Records Committee, 1987). The WLIP was officially established by legislation in 1989 and continues to be an active program under the Wisconsin Department of Administration (DOA) today.

The WLIP has always specified that county participation is voluntary. However, its financial incentives are strong enough that all counties in the state eventually chose to opt into the program. The WLIP provides funding to participants in the form of grants and allows them to keep a portion of the fees the state charges on real estate transactions (Wisconsin Land Information Board, 1991). In return, each county is required to operate a land information office and create specific geospatial datasets, known as Foundational Elements.

Since the counties must share certain Foundational Elements with the state, the WLIP began to advocate for counties to make this data freely available online to the public as well. Many of the land information offices across the state created websites with map viewers where the public could view valuable information. However, public access to the raw data files was not assured. Some counties restricted access to their geodata by charging fees or setting up licenses. These barriers created an environment that made it difficult for consumers to actually obtain public geodata.

Academic organizations were one of the entities in Wisconsin that could negotiate access to county geodata. Beginning in 2005, the University of Wisconsin-Madison's Arthur H. Robinson Map Library began acquiring local geodata directly from counties for use in academic research and teaching. At that time, over half of Wisconsin's 72 counties required the University to sign formal licenses or data sharing agreements indicating the data would only be used by UW-Madison users for academic purposes. Other counties agreed to share the data with the University without signing formal agreements, but the general understanding was that the data would be only used for academic purposes. This collection process was sporadic, as the library only requested and archived county geodata files when students or researchers specifically requested them. While this enabled continual growth of the data archive, holdings became inconsistent and unpredictable through time. As a result, the Robinson Map Library changed its county data collection process in 2012 to request a comprehensive set of data layers across all counties at the same time each year. This list of data layers was standardized to encourage broad participation. Based on previous experience, more favorable and timely responses were garnered when a specific set of layers was requested, as opposed to a catch-all 'give us what you have' request.

For many years, academic users needed to visit the library in person to obtain the data on CDs, DVDs, or portable hard drives. By 2012, advances in cloud-based file-sharing services enabled users to simply download the data directly from the internet. Users no longer needed to physically go to the library, because they could submit email requests to access the content at any time. However, the individual requests became too frequent to handle efficiently, and the data archive quickly reached a critical mass of temporally significant content.

In response to this growth, the Robinson Map Library made the pivotal decision to develop an online geoportal to serve as the discovery platform for all geodata in the archive. The library collaborated with the Wisconsin State Cartographer's Office and launched GeoData@Wisconsin[15] in 2014. Initially, the only users who were able to download resources from the geoportal were affiliates of UW-Madison. This restriction allowed the library to remain in compliance with data-sharing agreements that were still in place for nearly 40 counties. However, once users around the state became aware of the new geoportal, the library was inundated with geodata access requests from students and researchers at other Wisconsin campuses. The library staff surveyed the 72 Land Information Officers in each county and found that 70 of them were willing to share their geodata more widely, as long as it continued to be for academic purposes only. The library then changed the geoportal's authentication protocols to allow access for users affiliated with any University of Wisconsin system campus. To avoid having to programmatically address

multiple levels of access authentication, resources from the two counties that did not approve of broader access were simply removed from the geoportal.

At the same time, the broader open data movement was taking hold around the country, and there was a sense that the culture was changing in Wisconsin as well. Generational differences became apparent, and staff turnover in county land information offices resulted in different mindsets. Data storage and web hosting services became less expensive and easier to use, and the momentum grew as more and more counties began posting downloadable datasets online. Proponents across the state pointed out that the administrative costs of charging fees exceeded the revenue and that the increased user base that comes with free data could translate into increased economic activity. In this changing environment, a major development occurred: the passage of the Statewide Parcel Map Initiative. While this initiative alone might not be viewed as the only catalyst for establishing open geodata in Wisconsin, the totality of the environment in which it was adopted and carried out is certainly marked by that spirit.

The Statewide Parcel Map Initiative was established by Wisconsin Act 20, the biennial state of Wisconsin budget for 2013-2015. This act includes statutory directives for a multi-faceted, multi-year collaborative effort of the Department of Administration (DOA) and local governments to coordinate the development of a statewide digital parcel map. It requires counties to submit parcel datasets online in a standardized format and provides additional grant funding administered by the WLIP for counties to improve their parcel mapping (Wisc. Stat., § 59.72).

In addition to the parcel information explicitly called for by state law, DOA broadened their geodata collection scope in 2017 to include other common foundational datasets, such as address points, street centerlines, land use, zoning, rights of way, and more. The collection of other layers beyond parcels was not made inevitable by the passage of Act 20. The expansion was largely motivated by an effort to create a mutually beneficial data collection process for DOA and the Robinson Map Library, taking into account the process previously established by the library. DOA's inclusion of additional datasets was driven by the desire to create efficiencies, synergize, and assist where possible to help the library get closer to 100% compliance with their annual data request.

The Robinson Map Library plays a central role in creating geospatial metadata required for documenting data collected each year. DOA now makes geodata requests to the counties and directs them to send their datasets along with basic metadata to the library. Library staff then create fully valid ISO 19139 metadata and publish the datasets on GeoData@Wisconsin, which has since been fully opened to the general public. Now, any visitor to the site (not just academic affiliates) can browse and download public geodata.

This change in Wisconsin's open data landscape has been bumpy at times, as not everyone in the geospatial community was in support of the initiative at the start. In a small number of instances, counties that initially balked at DOA's request for other geodata layers beyond parcels eventually acceded to the request. Sometimes this involved the land information officer working on getting the county's official policy changed in cases where it was necessary to terminate local policies requiring signed license agreements and fees for the acquisition of data. In one case, DOA representatives went before a county land information council and successfully made the case for sharing the other layers over the objections of a county GIS staff person. For data not created with WLIP grant funding, the requirement for sharing may not be as direct, but Wisconsin's public records laws provide an additional basis for DOA to request, collect, and make the data open. Unless specifically exempted by federal law or statute, the requested datasets are assumed to be public records under state statute 19.31 and are therefore to be made available upon request (Wisc. Stat., § 19.31). In cases where a particular county was not sharing its data,

DOA officials have simply asked the county why the Wisconsin Public Records Law does not apply to the requested records in question. This is often sufficient to bring the county on board, particularly after pointing out that courts around the country have routinely ruled in favor of open data when statutes are challenged (Sierra Club v. S.C (County of Orange), 2013; WIREdata Inc. v. Village of Sussex, 2008.). Although great strides have been made in gaining open access to much county vector data, there has been less willingness to share raster data in a minority of counties. In 2018-2019, DOA began requesting LiDAR elevation datasets from individual counties. Three counties have denied the request because they charge a significant sum of money for the data and do not want the data available for free. DOA has decided to defer aggressively pursuing the LiDAR data from these three counties for now and focus on gathering data from other willing counties (Herreid & Veselenak, personal communication, Wisconsin Land Information Program (WLIP) and Act 20 email questionnaire responses, Feb 24, 2020).

Despite these challenges, a large amount of Wisconsin's county geodata has now become open data in practice. This can be generally attributed to leadership and support from members of the community, legislation, grant funding, and calls for increased transparency in government operations at all levels.

3.3 Commonalities and points of departure

One way of assessing a state's open data landscape is to tally the number of counties that are actively publishing it, either through their own hosted portal or by contributing directly to a state clearinghouse. From this perspective, the digital landscape in Minnesota and Wisconsin is similar. An examination of each state's public list of county-level GIS websites reveals that roughly half of the counties in each state self-publish open geodata. (Minnesota Geospatial Information Office, 2021; Wisconsin Land Information Program, 2021).[16]

Another quantitative method for assessing the open data landscape is to focus on the geographic availability of specific dataset themes. From this perspective, the two states are much more divergent. This evolution can be seen by examining the availability of county parcel datasets over time. At one time, Minnesota had more open parcel datasets than Wisconsin, but the situation has since flipped. Figure 2 illustrates Minnesota's early presence in online open geodata by showing the availability of county parcel datasets in 2005. In that year, eight counties in Minnesota were publishing parcel datasets - seven in the Twin Cities area through MetroGIS, along with the pioneering Clay County on the western border (which began the practice all the way back in 1999). There is not a reliable comparison to Wisconsin during this period, because the availability of parcel datasets fluctuated depending upon policies in each county at the time. Ten years later, the open data landscape in these states paints a different picture. Figure 3 displays which counties in Minnesota and Wisconsin published parcel data as open geodata in the year 2015. While six additional counties in Minnesota had joined the open geodata movement, Wisconsin now had full coverage of this data for every single county.

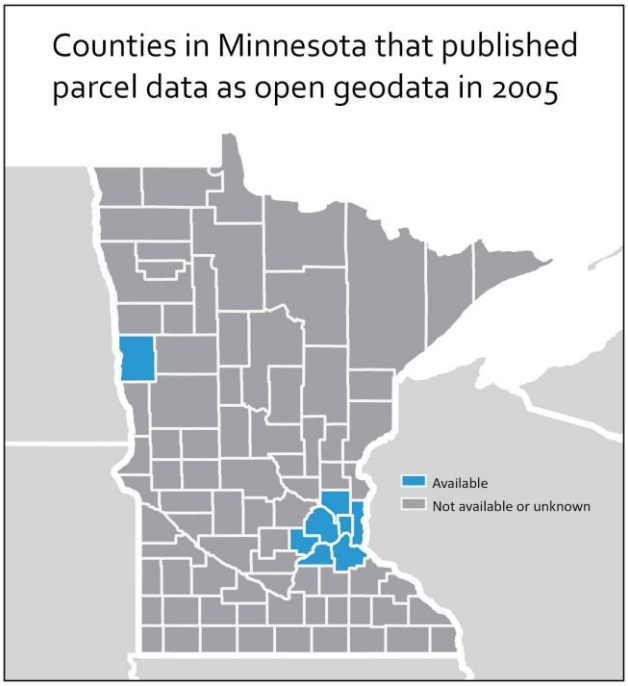

Figure 2: A map of Minnesota showing which counties published parcel data as open geodata in 2005.

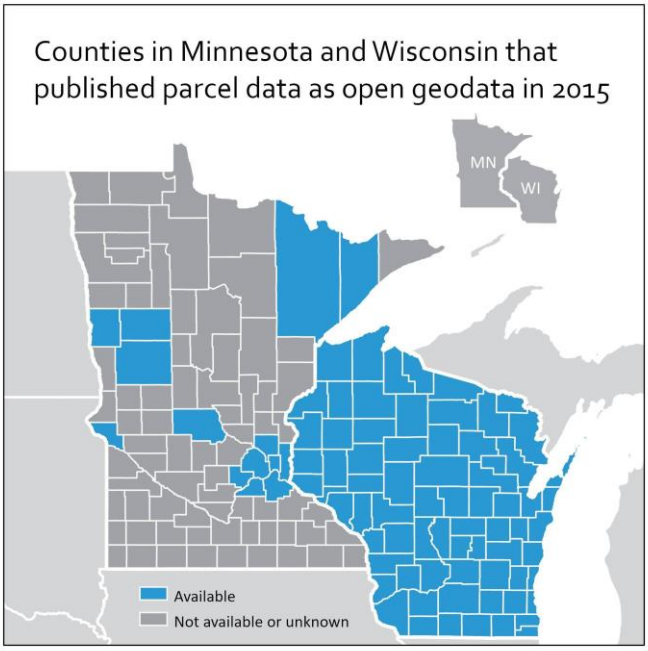

Figure 3: A map of Minnesota and Wisconsin showing which counties published parcel data as open geodata in 2015.

We have identified four areas that we believe have had the greatest impact on the differing landscapes of open geodata between Minnesota and Wisconsin.

1. Legislation

The two states have different approaches to how they regulate the public availability of county geodata. Both have long-standing statutes that define government data as open to the public. However, subsequent qualifications to this legislation have had substantial impacts on the open data landscape. In Minnesota, the Data Practices Act is not fully enforced, and an addendum allows counties to charge a fee to cover the cost of packaging and sharing their geodata. In Wisconsin, the language in the Public Records Law provided justification for a budget act that funds mandatory collection of parcel datasets. It also promoted the notion that more county-level geodata could become free and open.

2. Funding

Dedicated funding for local GIS departments makes a big difference for open data, particularly in rural counties. One effective funding mechanism is a recorder's fee attached to each real estate transaction. In Minnesota, counties can optionally use this fee to fund their GIS work, but many choose to spend the funds another way. In Wisconsin, every county participating in the WLIP is required to have a land information office that is funded through retained fees and grants from the program. Counties retain a portion of a dedicated $15 real estate document recording fee to fund their land information work, while the remainder is allocated to the state's land information fund. This fund provides base budget grants to counties that see fewer real estate transactions and generate less than $100,000 per year in retained fees. However, the counties must participate in the program to submit foundational datasets to the state, or else they may not be eligible to receive grant funding. County geodata produced with WLIP funding and submitted to the annual call for data is open and publicly accessible.

3. Workflows

Another discrepancy between the states can be seen in how local governments participate in their state's central geodata platform. Minnesota uses a self-service model for contributions to the state geodata platform. Although a state agency administers the Commons platform itself, the content is fully the responsibility of the contributors. Counties need to set up a local node on a file-sharing application, write their own metadata, and upload it bundled with their datasets to the Commons; these are all tasks that require a fair amount of staff time to perform. The Commons also requires valid metadata that conforms to the state guidelines. Without validation, the submission will not go through. This keeps the quality of the data in the Commons very high but has the effect of preventing some counties from participating. Out of the 45 counties that have open geodata, only ten contribute to the Commons. In Wisconsin, workflows are more centralized. All counties send specified datasets to the State Cartographer's Office and the Robinson Map Library. Staff at the State Cartographer's Office process the tax parcel data for the creation of the statewide layer, while library staff write full standards metadata for all the incoming datasets and publish them to a geoportal. The geoportal is developed and maintained by the State Cartographer's Office and Map Library, both units at the University of Wisconsin-Madison.

4. Library Involvement

Currently, both states have some level of academic library involvement in open data workflows and discussions. In Minnesota, the Borchert Map Library is an active participant in the state's efforts around open data. It is one of the contributors to the Commons, and it hosts one of the most used geospatial access points in the form of a historical aerial photograph finder. More recently, the library has begun to make plans for archiving open geodata in the same way it has done for public domain maps for decades. In Wisconsin, the Robinson Map Library has been involved in collecting, archiving, and disseminating

geospatial data since 2005. The library's process of curating geospatial collections for academic research (out of necessity for users) evolved from user-specific acquisitions to a consistent annual collection of county geospatial data for all of Wisconsin. Over time, this focused effort became a more formal process with goals for broader access expanding into long-term preservation of the data as well. With the library's annual data acquisition process in place, it made sense to couple it with the statewide parcel initiative beginning in 2017. Doing so means less of a burden for county data providers who only need to respond to a single data request each year. An added benefit to the library's formal role in Wisconsin's open data acquisition process is the creation of standards-based geospatial metadata. Both descriptive and discovery metadata are created by library staff and student assistants with guidelines in place that make the records accurate and consistent. Student assistants have always been a significant part of the geospatial metadata workflow. A primary goal of the library is to hire and train students in relevant educational programs. Students obtain worthwhile training, education, and applied work experience in data management and documentation.

3.4 Additional Observations

We speculate that Minnesota's early flourishing in GIS technology could have actually impeded their later open geodata efforts. For example, Minnesota was one of the first states in the nation to create geodata on a statewide scale and one of the first to deliver it via open data portals. Students and researchers could access open geodata through multiple portals as far back as the 1990s. Meanwhile, students and researchers in Wisconsin continued to face significant challenges in obtaining geodata without the assistance of the university negotiating on their behalf. This prompted the Robinson Map Library to build a geodata archive years before the Borchert Map Library began investigating a similar project. Minnesota, with its plethora of voluntary open geodata, has not had a comparable collection program that can be easily converted into an archive. Interestingly, in late 2020, the University of Minnesota's U-Spatial program[17] began offering limited access to parcel data for every county in the state using a model similar to what the Robinson Map Library started doing in 2005. Through this arrangement, students and researchers may request authorized access to parcel data but must agree to use it for research purposes only and not share it.

Another example of early adoption impeding later progress is the status of Minnesota's metadata guidelines and accompanying tools. MGMG is deeply enmeshed in the documentation and workflows for state agencies and the Commons. This is evidenced in the longevity of the primary MGMG authoring tool, known as the Minnesota Metadata Editor (MME). In the intervening years since MGMG and MME were developed, the International Standards Organization released a new geospatial metadata standard, the ISO 191xx series, and ArcGIS for Desktop became the most widely used tool for creating it. In response to these developments, a GAC metadata workgroup analyzed MGMG's compatibility with ISO and the ArcGIS authoring tools. The workgroup concluded in 2017 that 'there are not yet sufficient business needs to migrate MGMG to be fully compliant with ISO' (Minnesota Geospatial Advisory Council, 2017). Although the workgroup identified techniques for using ArcGIS, MME remains the most reliable tool for generating valid MGMG. This is a point of frustration for data creators because MME is an outdated Windows-only application that relies upon Microsoft Access, a deprecated program.

In contrast, Wisconsin has been able to be more nimble about technological adoption for open data as its efforts have been more recent. The Robinson Map Library uses ArcGIS Pro to create metadata, which can export to either the FGDC or ISO standard. They also have been able to take advantage of a more modern interface, GeoBlacklight, which incorporates geospatial web service previews into item view pages. Minnesota had thoroughly developed a state geodata platform before ArcGIS Hub or GeoBlacklight had

matured as technology options, and it remains invested in using CKAN, a technology designed for general purpose data.

Our examination of the open geodata landscapes in each state indicates that if a government entity values open data, it should look to Wisconsin as a model. However, Wisconsin's success story may not be well-known outside of their state. It was not evident in the most recent survey of the National States Geographic Information Council (NSGIC) (2019). NSGIC conducts surveys every two years to summarize and evaluate the geospatial maturity of each state. Although free and open data is one component of the scoring metric, it is not a significant focus of the assessment. The 2019 NSGIC survey gave Minnesota a grade of 'A' for statewide geospatial coordination. Wisconsin received a 'D.' This result is puzzling, as Wisconsin is arguably well-coordinated in terms of statewide geospatial activities. For example, Wisconsin is one of the only states to require that every county establish a land information office and council, and a dedicated state agency distributes funds to each county. However, the survey did not pose questions related to these aspects. The second area where Wisconsin lost many points was whether or not an official state clearinghouse existed. Although the University of Wisconsin-Madison maintains a large geoportal that is at least as comprehensive as any across the country, it was not represented in the NSGIC survey as an official state clearinghouse. On the whole, the survey's language often matched Minnesota's structure but did not reward Wisconsin.

4. Conclusion

When will the conference attendee we described in our introduction be able to freely download a parcel dataset for every county in Minnesota? As of 2021, Minnesota continues to gradually increase the number of counties offering open geodata, with a pattern of several new ones signing on every year. Although Minnesota has many enthusiastic open data supporters that are making real progress, it seems unlikely that the state will attain full open coverage of foundational layers like parcels without adopting one or more of Wisconsin's strategies. Based upon our case study of Wisconsin, we can predict that a few of the remaining Minnesota counties will only embrace open geodata if they are mandated to do so while receiving centralized support on multiple fronts. They need dedicated funding for staff positions and technical support for metadata services along with an easy-to-use centralized platform. The state government plays a role by passing legislation and providing a financial incentive, while the libraries are well-suited to play an essential role in resource discovery, metadata, and preservation.

References

Arbeit, D. *et al.* (2004) *A Foundation for Coordinated GIS: Minnesota's Spatial Data Infrastructure.* Minnesota Governor's Council on Geographic Information. Available at: https://www.mngeo.state.mn.us/MSDI/MN_IPlan_Consolidation_Final_04OCT04.pdf (Accessed: 19 February 2020).

Blatt, A. J. (2016) 'Open-Access Geospatial Data: Promise and Potential', *Journal of Map & Geography Libraries*, 12(2), pp. 216–222. doi: https://doi.org/10.1080/15420353.2015.1125405.

Dyke, K. R. et al. (2016) 'Placing Data in the Land of 10,000 Lakes: Navigating the History and Future of Geospatial Data Production, Stewardship, and Archiving in Minnesota', *Journal of Map & Geography Libraries*, 12(1), pp. 52–72. doi: https://doi.org/10.1080/15420353.2015.1073655.

Federal Geographic Data Committee (1994) *The 1994 Plan for the National Spatial Data Infrastructure.* Reston, Virginia. Available at: https://www.fgdc.gov/policyandplanning/NSDI%20Strategy%201994.pdf.

Federal Geographic Data Committee (1997) *A strategy for the National Spatial Data Infrastructure.* Reston, VA. Available at: https://hdl.handle.net/2027/umn.31951d01539752a.

Harvey, F. and Tulloch, D. (2006) 'Local-government data sharing: Evaluating the foundations of spatial data infrastructures', *International Journal of Geographical Information Science*, 20(7), pp. 743–768. doi: https://doi.org/10.1080/13658810600661607.

Joffe, B. (2003) '10 Ways to Support Your GIS Without Selling Data'. Available at: https://umaine.edu/computingcoursematerials/wp-content/uploads/sites/511/2017/02/TenWays.pdf.

Johnson, P. A. et al. (2017) 'The Cost(s) of Geospatial Open Data', *Transactions in GIS*, 21(3), pp. 434–445. doi: https://doi.org/10.1111/tgis.12283.

Kemp, B. (2017) 'Implementation of NG9-1-1 in Rural America–The Counties of Southern Illinois: Experience and Opportunities', *IEEE Communications Magazine*, 55(1), pp. 152–158. doi: https://doi.org/10.1109/MCOM.2017.1600457CM.

Kramers, E. R. (2008) 'Interaction with Maps on the Internet – A User Centred Design Approach for The Atlas of Canada', *The Cartographic Journal*, 45(2), pp. 98–107. doi: https://doi.org/10.1179/174327708X305094.

Library of Congress (2021) *Sustainability of Digital Formats: Planning for Library of Congress Collections*. Available at: https://www.loc.gov/preservation/digital/formats/fdd/fdd000280.shtml (Accessed: 22 September 2021).

Maas, G. (2013) *Research & Reference Documents*. White paper. Minnesota: MetroGIS. Available at: https://www.metrogis.org/getmedia/a766418c-87a5-4e73-a87e-187022b04d50/METROGIS_FREE_OPEN_DATA_RESEARCH_RESOURCES3.pdf.aspx.

Maas, G. (2019) *Questions, Answers, Concepts, and Resources for Practitioners*. White paper Version 6.3. Minnesota: MetroGIS. Available at: https://www.metrogis.org/getmedia/e6a25fbe-89cd-43db-a80d-fa32fc5ea287/FREE_OPEN_DATA_VERSION_6_3.pdf.aspx.

McAuliffe, C. P., Lage, K. and Mattke, R. (2017) 'Access to Online Historical Aerial Photography Collections: Past Practice, Present State, and Future Opportunities', *Journal of Map & Geography Libraries*, 13(2), pp. 198–221. doi: https://doi.org/10.1080/15420353.2017.1334252.

Minnesota Geospatial Advisory Council (2018) 'Minnesota Governor's Geospatial Commendation Award Nomination'. Available at: https://www.mngeo.state.mn.us/awards/gov_commendations/GovGeospatialCommendationNomination_UMN_BorchertMapLibrary_2018.pdf.

Minnesota Geospatial Advisory Council (2017) *Metadata Workgroup Final Report*. Minnesota Geospatial Advisory Council. Available at: https://www.mngeo.state.mn.us/workgroup/metadata/metadata_workgroup_final_report_2017.pdf.

Minnesota Geospatial Advisory Council Outreach Committee (2016) *Free and Open Public Geospatial Data: 2016 Outreach Survey Results and Report*. Minnesota Geospatial Advisory Council. Available at: https://www.mngeo.state.mn.us/committee/outreach/OpenDataSurveyFindingsReport.pdf.

Minnesota Geospatial Information Office (2021) 'Status of Free and Open Public Geospatial Data from Minnesota Counties'. Available at: https://gisdata.mn.gov/dataset/bdry-mn-county-open-data-status.

Minnesota Government Data Practices Act (1974) Minnesota Statutes § 13. Available at: https://www.revisor.mn.gov/statutes/cite/13 (Accessed: 19 February 2020).

Minnesota Government Data Practices Act (1990) Minnesota Statutes § 13.03(d. Available at: https://www.revisor.mn.gov/statutes/cite/13 (Accessed: 19 February 2020).

Minnesota Governor's Council on Geographic Information (1998) *Minnesota Geographic Metadata Guidelines*. Available at: https://mn.gov/mnit/government/policies/geo/mn-geographic-metadata.jsp.

Minnesota Governor's Council on Geographic Information (2009) *Annual Report*. Available at: https://www.lrl.mn.gov/docs/2010/other/100728.pdf.

National Emergency Number Association (2020) *NENA Standard for NG9-1-1 GIS Data Model*. Available at: https://cdn.ymaws.com/www.nena.org/resource/resmgr/standards/nena-sta-006.1.1-2020_ng9-1-.pdf (Accessed: 6 March 2020).

National Research Council (1980) *Need for a Multipurpose Cadastre*. doi: https://doi.org/10.17226/10989.

National Research Council (2007) *National land parcel data: a vision for the future*. Washington, D.C.: National Academies Press.

National States Geographic Information Council (2019) *2019 Geospatial Maturity Assessment State Report Cards*. Available at: https://nsgic.memberclicks.net/assets/2019GMARawResults/2019GMAReportCards/GMA%20State%20Report%20Cards.pdf.

Open Knowledge Foundation (no date) *Open Definition 2.1 - Open Definition - Defining Open in Open Data, Open Content and Open Knowledge*. Available at: https://opendefinition.org/od/2.1/en/ (Accessed: 12 March 2020).

Sierra Club v. S.C (County of Orange), No. S194708 (California Supreme Court 2013).

Sui, D. (2014) 'Opportunities and Impediments for Open GIS', *Transactions in GIS*, 18(1), pp. 1–24. doi: https://doi.org/10.1111/tgis.12075.

Terner, M., Buck, A., and Applied Geographics, Inc. (2009) *A Program for Transformed GIS in the State of Minnesota: Program Design & Implementation Plan*. Available at: https://www.mngeo.state.mn.us/MSDI/dte/ProgramDesign_FinalFeb09_V21.pdf (Accessed: 19 February 2020).

Tombs, R. B. (2005) 'Policy review: Blocking public geospatial data access is not only a homeland security risk', *Journal of the Urban & Regional Information Systems Association*, 16(2), pp. 49–51.

Tulloch, D. and Fuld, J. (2001) 'Exploring County-level Production of Framework Data: Analysis of the National Framework Data Survey', *URISA Journal*. Available at: https://www.researchgate.net/publication/239984711_Exploring_County-level_Production_of_Framework_Data_Analysis_of_the_National_Framework_Data_Survey.

University of Minnesota. Center for Urban and Regional Affairs (1976) *Overview of the Minnesota Land Management Information System*. [Minn.]: University of Minnesota Center for Urban and Regional Affairs.

U.S. Department of Housing and Urban Development (2013) *The Feasibility of Developing a National Parcel Database: County Data Records Project Final Report*. Available at: https://www.huduser.gov/portal/Publications/pdf/feasibility_nat_db.pdf (Accessed: 6 March 2020).

Warnecke, L. (1992) 'Minnesota', in *State Geographic Information Activities Compendium*. Lexington, Ky: Council of State Governments, pp. 212–245.

WIREdata, Inc. v. Village of Sussex, 751 NW 2d 736 (Wisconsin Supreme Court 2008).

Wirtz, B. W. et al. (2016) 'Resistance of Public Personnel to Open Government: A cognitive theory view of implementation barriers towards open government data', *Public Management Review*, 18(9), pp. 1335–1364. doi: https://doi.org/10.1080/14719037.2015.1103889.

Wisconsin Land Information Board (1991) *Recommendations and Requirements for County-Wide Plans for Land Records Modernization.* Available at: https://doa.wi.gov/DIR/1991_Plan_Instructions.pdf.

Wisconsin Land Information Program (2021) 'County Contacts and Websites'. Available at: https://doa.wi.gov/DIR/County_Contacts.pdf.

Wisconsin Land Records Committee (1987) *Final Report of the Wisconsin Land Records Committee: Modernizing Wisconsin's Land Records*. Madison, Wisconsin. Available at: https://doa.wi.gov/DIR/1987_Report_Land_Records_Committee.pdf.

Wisconsin Statutes § 19.31 (1981) Available at: https://docs.legis.wisconsin.gov/statutes/statutes/19/II/31 (Accessed: 10 June 2021).

Wisconsin Statutes § 59.72 (2013) Available at: https://docs.legis.wisconsin.gov/statutes/statutes/59/VII/72 (Accessed: 10 June 2021).

Wood, C. (2020) *States need to improve for national GIS infrastructure to work, report says.* StateScoop. Available at: https://statescoop.com/nsgic-geospatial-maturity-assessment-state-gis-report-card/ (Accessed: 6 March 2020).

Endnotes

[1] Karen Majewicz is the Geospatial Project Manager and Metadata Coordinator at the John R. Borchert Map Library, University of Minnesota (majew030@umn.edu)
[2] Jaime Martindale is the Map & Geospatial Data Librarian at the Arthur H. Robinson Map Library, University of Wisconsin-Madison (jmartindale@wisc.edu)
[3] Melinda Kernik is the Spatial Data Analyst and Curator at the John R. Borchert Map Library, University of Minnesota (kerni016@umn.edu)
[4] Yijing Zhou is the GIS & Metadata Programming Intern for the BTAA Geoportal, University of Minnesota
[5] CKAN, https://ckan.org
[6] Socrata, https://www.tylertech.com/products/socrata
[7] ArcGIS Hub, https://hub.arcgis.com
[8] GeoBlacklight, https://geoblacklight.org
[9] Minnesota Department of Natural Resources GIS Data Deli, https://web.archive.org/web/19991013033555/http://deli.dnr.state.mn.us/
[10] MetroGIS Data Finder, https://web.archive.org/web/19981203091211/http://www.datafinder.org/
[11] Minnesota Geospatial Commons, https://gisdata.mn.gov
[12] Metro GIS - Free and Open Data, https://www.metrogis.org/projects/free-open-data.aspx
[13] Minnesota Historical Aerial Photography (MHAPO), https://apps.lib.umn.edu/mhapo
[14] BTAA Geoportal, https://geo.btaa.org
[15] GeoData@Wisconsin, https://geodata.wisc.edu
[16] These lists are frequently updated. Consult the latest version of the Status of Free and Open Geospatial Data from Minnesota, https://gisdata.mn.gov/dataset/bdry-mn-county-open-data-status and County Contacts, https://doa.wi.gov/DIR/County_Contacts.pdf, for the most up-to-date information.
[17] U-Spatial, University of Minnesota, https://research.umn.edu/units/uspatial/resources/spatial-data