

Advancing the Nation's Geospatial Ecosystem: Guidance and Best Practices for Sharing Priority National Data

Executive Summary

To advance the nation's geospatial ecosystem, the National Geospatial Advisory Committee (NGAC) offers recommendations for sharing priority data critical to our National Spatial Data Infrastructure (NSDI). These recommendations support the [NSDI Strategic Plan 2025-2035](#) goals for "critical and trustworthy geospatial data that are readily available to all users, thereby ensuring an opportunity for consistent, equitable, and quality decision-making."

This report refers to priority national data as collectively including, but not limited to, our National Geospatial Data Assets (NGDAs) identified by the Federal Geographic Data Committee (FGDC) and "priority national datasets" identified in the NSDI 2035 Strategic Plan.

Recommendations

For the broad community of organizations and users that rely on priority national data, this information should be easy to find, accessible, reliable, integrable, and understandable. In other words, these resources must be **ready-to-use data**.

NGAC recommends that the FGDC endorse and promote this guidance, distilled from proven practices for sharing priority national datasets. Specifically federal agencies are urged to:

1. Prepare ready-to-use data.
2. Share readily available data in multiple formats.
3. Ensure data is reusable, with reliable and persistent URLs.
4. Consistently use open data licenses.
5. Optimize data for discovery, usability, and AI readiness.
6. Archive data for posterity.

NGAC further recommends that the FGDC:

7. Develop and endorse a definition of authoritative geospatial data.
8. Monitor implementation of these recommendations and the use of priority national data.

The FGDC should encourage federal and non-federal partners to embrace this multi-pronged approach to empower NSDI implementation and maximize its impact.

Advancing the Nation's Geospatial Ecosystem

To advance the nation's geospatial ecosystem, the National Geospatial Advisory Committee (NGAC) has identified key guidance based on proven practices for data sharing. The recommendations herein aim to support the National Spatial Data Infrastructure (NSDI)

Strategic Plan 2025–2035 mission to deliver highly responsive, timely, dependable, and interoperable geospatial data, applications, and services that provide knowledge on demand and actionable insights to inform decisions; address local, regional, national, and global challenges; and benefit all people.

This report refers to priority national data as collectively including (but not limited to) our National Geospatial Data Assets (NGDAs) identified by the Federal Geographic Data Committee (FGDC) and "priority national datasets" identified in the Plan.

The following recommendations support the Plan's goals to ensure that priority national data is easy to find, accessible, reliable, integrable, and understandable for all users. This multi-pronged approach aims to empower NSDI implementation and maximize its impact.

Recommendations for sharing priority national data

1. Prepare ready-to-use data

When data is provided as a ready-to-use information product, its utilization increases. The more data is used, the higher its return on investment. Ready-to-use data is easy to find, easy to understand, and easy to work with. It is reliable and relevant to a broad community of beneficiaries.

Recommendation: NGAC recommends the FGDC:

- Endorse and promote guidance for sharing priority national data in ready-to-use condition, based on proven practices herein.

2. Share readily available data in multiple formats

The Geospatial Data Act (GDA) of 2018 requires that geospatial data be made available through the GeoPlatform via download access and a set of programming instructions and standards providing an automated means of accessing available geospatial data.

To further enable the NSDI vision, we interpret this to mean downloads in a variety of formats together with web services that stream data content using RESTful application programming interfaces (APIs). Supporting this, the US Department of Commerce describes how data should be available to support artificial intelligence (AI) and open data, minimally as RESTful APIs and direct download. (US Department of Commerce, 2025)

Recommendation: NGAC recommends the FGDC:

- Build on the intent specified in the GDA regarding the availability of data available through the Geoplatfrom, by ensuring that priority national datasets *must be* available as scalable, performant web services with REST APIs and direct download access.
- Additionally, priority national datasets *should be* shared as ready-to-use datasets and maps, graphics and apps that provide visual and summary context. Over time and with appropriate preparation, priority national datasets *should be* available for use with emerging technologies, such as AI assistants.

3. Ensure data is reusable with reliable persistent URLs

The ability to use, integrate, and repurpose geospatial data is considered a key benefit of the NSDI for the broader community of beneficiaries. Reuses include using ready-to-use datasets and web services in maps and apps, analyses, derivative datasets, and more. Dynamic reuse depends on stable, reliable, and persistent URL endpoints for the data files and services. Publishing web services establishes an ongoing, end user expectation for continuity.

Recommendation: NGAC recommends the FGDC:

- Endorse and promote the best practice of maintaining web services and ready-to-use data layers with reliable and persistent URLs.

4. Consistently use open data licenses

Congress finds that “open and publicly available data is essential to the successful operation of the GeoPlatform” (GDA 2018 - [Sec. 751 b.1](#)). Additionally, the goals of the NSDI include free and open access for the public to geospatial data, information, and interpretive products, in accordance with Office of Management and Budget Circular A-13.

However, authoritative geospatial data providers use a wide variety of license and terms of use statements. Reuse of federal geospatial data – including NGDAs – can be hindered by the absence of licenses and terms of use, or where provided, its complexity and lack of uniformity. The current diversity of approaches results in underutilized priority national datasets.

Recommendation: NGAC recommends the FGDC:

- Endorse a single open or small set of open licenses for use with federal geospatial data (e.g., the Creative Commons Zero (CC0) Public Domain Dedication).
- Advise federal agencies of their responsibility to provide free, open access to the public.
- Advise federal and non-federal data providers on use of open data licenses, including how to document licenses in the geospatial metadata terms of use and legal constraints.
- Require that priority national datasets, including National Geospatial Data Asset (NGDA) data layers, be provided under an open data license.

5. Optimize data for discovery, usability, and AI readiness

When geospatial data is optimized for discovery, usability, and AI readiness, it is easy to understand at a glance. Search-engine-optimized geospatial data is easy to find across a wide variety of channels in a national and global data ecosystem. This includes data catalogs, portals, content management systems, search engine results pages (SERP), and AI assistants.

Recommendation: NGAC recommends the FGDC:

- Endorse and urge the adoption of proven practices to ensure that priority national data is optimized for discovery, usability, interoperability, and AI readiness.
 - Apply best practices for priority metadata elements (see Table 1).
 - Identify authoritative data.
 - Employ search engine optimization techniques.

6. Archive data for posterity

In 2003, the FGDC issued guidance for federal agencies, Managing Historical Geospatial Data Records. Data archiving is a process that supports long-term storage of scientific data and the methods used to read or interpret it. Archiving data ensures that valuable data is preserved for future use by storing it long-term, even if it is no longer needed for immediate access. (FGDC 2003)

Recommendation: NGAC recommends the FGDC:

- Review the 2003 FGDC guidance to ensure it is current with National Archives and Records Administration (NARA) requirements and industry best practices, and update it as needed.
- Renew endorsement of the FGDC guidance and encourage all agencies to submit data for archiving, annually or other appropriate periodic schedules.

Additional Recommendations

7. Define authoritative

Identifying authoritative data is crucial for achieving the NSDI 2035 vision of trusted and curated data. The NSDI 2035 Strategic Plan aims to establish comprehensive and authoritative national geospatial data to support informed decision-making, economic growth, and national security.

In this document, we use 'authoritative data' as meaning data recommended by a verifiable authority for its quality, accuracy, completeness, precision, and currency, and, suitable and accessible for supporting analysis and derivative information products. Authoritative data is most often primary source data or an aggregation of primary source data.

Recommendation: NGAC recommends the FGDC:

- Develop and endorse a definition of authoritative geospatial data.

8. Monitor implementation and use

Monitoring the implementation of best practices and measuring the utilization of data resources enhances accountability. Moreover, it helps promote continuous improvement, including ongoing or future data investments, ultimately enhancing the effectiveness and impact of the NSDI.

Recommendation: NGAC recommends that the FGDC:

- Monitor the implementation of these best practices and measure the utilization of priority national data.
- Incorporate these best practices when refining and simplifying GDA reporting processes.

Conclusion:

This multi-pronged list of eight important best practices is recommended by NGAC to enhance our NSDI and maximize the impact of our priority national dataset in meeting the evolving needs of industry, government, and the public for years to come.

NGAC has developed two draft appendices to supplement this document. These will be provided separately to the FGDC as working products. NGAC may develop these appendices into standalone recommendation papers at a later date. However, FGDC is encouraged to use these working products to support the implementation of these best practices recommended above, including, but not limited to developing guidance to be shared with federal agencies, and the broader NSDI stakeholder community.

Table 1. An example of priority metadata elements to optimize data for discovery, reuse, and AI readiness, regardless of the specific metadata standard used.

Metadata element	Guidance	Best practice
Title	Optimize titles for discovery and AI readiness	Use concise, descriptive, and distinct titles. Follow the pattern: What (topic) of Where (location), and When (time period), if relevant.
Summary	Engage potential users and optimize for discovery	Provide a brief, engaging summary of the purpose and use cases for the content that will appear in galleries and search results, reaching broad audiences. Include keywords different from words in your title to increase findability and search engine optimization. Aim for between 120 and 250 characters and an 8th grade reading level. Consider using a readability checker to assess reading ease.
Thumbnail	Capture attention	Add appealing preview images to engage users and help them understand content at a glance. Provide a preview image (600 x 400 or larger).
Description	Make it understood	Describe what your content is about. For example, a good description conveys "what" the data represents, "where" the data is located, "how" accurate it is, "when" it was collected, and "who" collected it.
Tags	Be specific	Provide at least three key-word tags using narrower terms than in the title or summary to use in galleries and search results and increase the findability of the resource. Include complete spellings and common acronyms.
Categories	Make it sortable	Provide at least one ISO theme key word to aid categorization, browsing, search, and discovery.
Terms of Use	Communicate license and constraints	Include an open data license for eligible datasets. As needed, include general use limitations, restrictions, and constraints. Describe any terms or conditions to help users understand how the content should or should not be used.
Acknowledgment	Give credit	Provide a concise name of the data source to display in digital map attribution. Organizational abbreviations are appropriate.
Extent	Locate the data	Provide the geographic extent of the dataset content for search using bounding box coordinates in WGS84.
Attributes	Make it useful	Provide data attribute field display names and attribute field descriptions to ensure data are well-understood.
Status	Manage change	Include the lifecycle status of the dataset as it changes, for example, when deprecating content.

Appendix A

Guidance and best practices for sharing

We encourage the adoption of this guidance by authoritative data providers, including federal agencies and other data providers throughout the broader national geospatial ecosystem.

Prepare ready-to-use data

When data is delivered in ways that are ready-to-use, its use increases. The more data is used, the higher its return on investment.

Ready-to-use data is:

- **Easy-to-find**, available, and discoverable in a self-service global ecosystem
- **Easy-to understand**, self-describing, symbolized, and configured for quick visualization
- **Easy-to use**, readily available, scalable, performant, interoperable, and licensed for reuse.
- **Reliable**, persistent, with known data product lifecycles.
- **Relevant**, analysis-ready, and fit to use, enabling access to quality features with well-documented attributes and key fields for joining with other data.

Guidance: Prepare priority national data to be ready-to-use.

Share readily available data in multiple ways

Readily available data enable users to leverage spatial information effectively in various applications and workflows, including self-service Web GIS architectures and geospatial ecosystems.

Readily available data is:

- **Accessible:** Users can access the data from anywhere with an internet connection, making it convenient for remote access and collaboration.
- **Scalable and performant:** Web services must handle large volumes of data and user requests. This makes it possible to deliver popular data to wide audiences.
- **Interoperable:** Different applications and systems can easily interact with and consume data using open standards and specifications.
- **Current:** Users can get the most recent available data from the provider. The frequency of updates may range from continual to irregular (depending on the nature of the data and collection).
- **Discoverable:** Humans and machines can find the data via many discovery channels, including applications, portals (e.g., [GeoPlatform](#)), hubs, catalogs, web search engines, and integrated products.

The NSDI Strategic Plan emphasizes that to solve our nation's current and future challenges, we need to have timely access to geospatial data, information, and knowledge. The national

geospatial ecosystem should connect all users with geospatial data, maps, easy-to-use tools, models, solutions, advanced capabilities, and emerging technologies. (FGDC , 2024)

Guidance: NGAC recommends the FGDC interpret the GDA language regarding availability of data available through the Geoplatform as meaning priority national datasets *must be* available as web services with REST APIs and direct download access. Additionally, priority national datasets *should be* shared as ready-to-use data layers and interpretive products (i.e., maps and apps). Over time and with appropriate preparation, priority national datasets *should be* available for use with emerging technologies, such as AI assistants.

Sharing formats

Readily available data ensures discovery and access using a variety of modalities. The following provide best practices on some of the ways to share.

Web services

Web services that use RESTful API technology allow different applications to communicate with each other over the internet. REST APIs are a proven and easy-to-understand way for a variety of different systems and applications to request map, feature, attribute, and image information from a geographic information system (GIS) server. API access is particularly important when data is updated frequently. (US Census Bureau, US Department of Commerce, 2025)

Best practice: Publish data using web services with RESTful API.

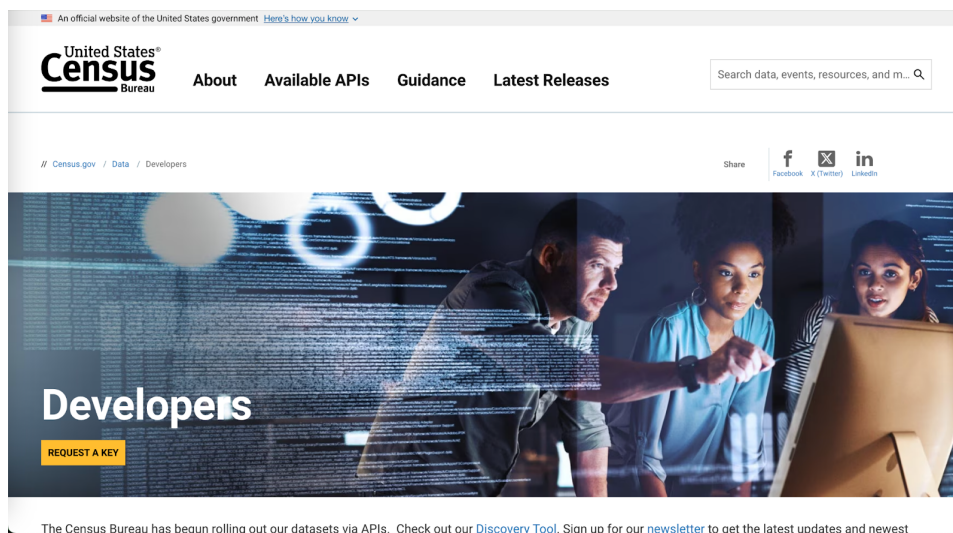


Figure X. The US Census Bureau's API allows developers to design web and mobile apps to explore or learn more about America's changing population and economy, including the TIGERweb GeoServices REST API

https://tigerweb.geo.census.gov/tigerwebmain/TIGERweb_restmapservice.html

Downloads

Direct download files, existing in locations that are easily parsable and predictable, allow users to retrieve entire datasets in one operation without needing additional programming or API knowledge. (US Dept of Commerce, 2025)

This method is especially useful for users who want to store or process datasets locally, as it provides a straightforward way to obtain the data in bulk. Additionally, for users with intermittent or limited internet access, being able to download a dataset in one go, store it, and work offline is a significant advantage. However, provisioning data via direct download alone is insufficient to provide the near real-time data retrieval necessary to meet the needs of users requiring up to date information. (US Dept of Commerce, 2025)

Best practice: In addition to API access, data should be available for download in a variety of formats, for example:

- Original data (Shapefile, GeoPackage, geodatabase, etc)
- Attribute data only (CSV, etc)

We also recommend providing PDF for offline use or that a portal offers the option to generate a PDF – see Information Products section below. Note, big data and dynamic data present unique challenges for sharing as downloadable data, with considerations that are beyond the scope of these recommendations.

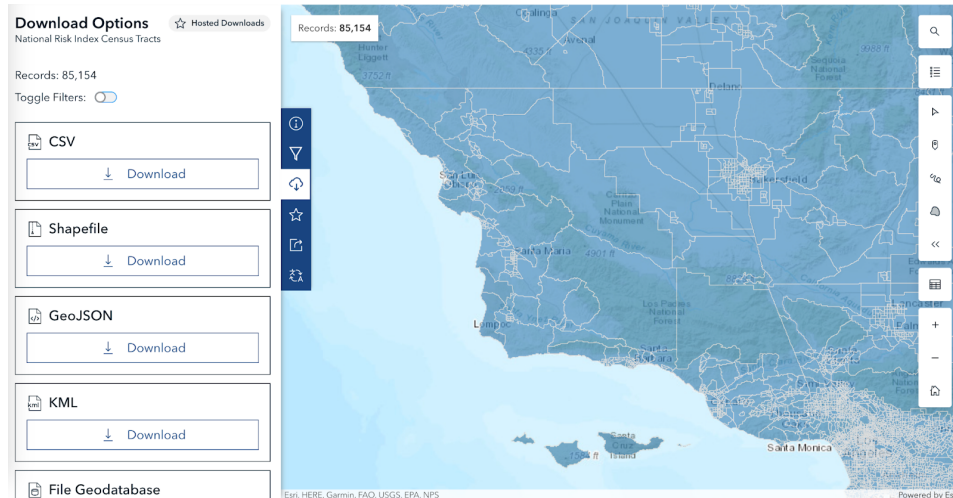


Figure X. FEMA's National Risk Index Census Tracts is available for download in multiple download options, including Shapefile, GeoJSON, KML, GeoPackage, and more.

<https://resilience.climate.gov/datasets/FEMA::national-risk-index-census-tracts/about> (accessed 18-Jan 2025)

Data layers

In the context of geospatial data on the web, data layers provide configurations and are backed by (or reference) web services. Configuration can include visualization properties (e.g., style and symbols, zoom, scale, and popups), and tightly-coupled metadata (e.g., data dictionary).

Data layers can offer several advantages that help make geospatial data ready-to-use. They support workflows to create and share readily accessible data. Ready-to-use data layers broaden the availability of web services to more users. They help make data easy to understand and use in maps and apps.

Best practice: Configure data layers for friendly reuse.

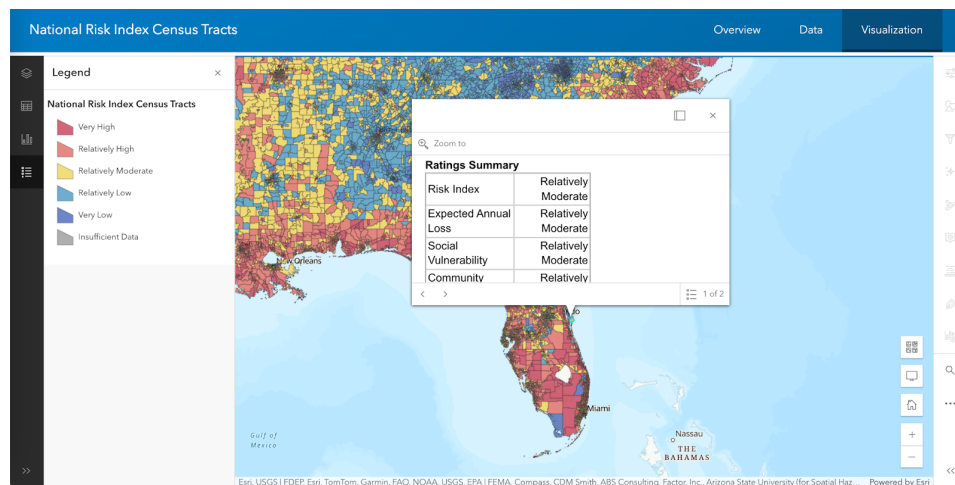


Figure X. FEMA's National Risk Index Census Tracts is shared as a ready-to-use feature layer. <https://www.arcgis.com/home/item.html?id=9da4eeb936544335a6db0cd7a8448a51> (accessed 18-Jan 2025)

Additional ways to share

Many people are hungry for knowledge and understanding but don't know how to work with GIS. Interpretive products help information consumers access and understand data without the need for specialized tools or know-how.

In addition to publishing geospatial data in structured file formats and services, agencies should of course endeavor to use web-based viewers and documents to provide the contained data as publicly digestible information.

Interpretive products

Interpretive products include tables, charts, maps, apps, PDF maps, and more. Dashboards and stories are common types of interpretive products for geospatial data.

Best practice: Share versions of authoritative data using interpretive products, as appropriate to different data types and audiences. Depending on the scale and data type, these may be available as a map or set of maps (PDF, GeoPDF, etc).

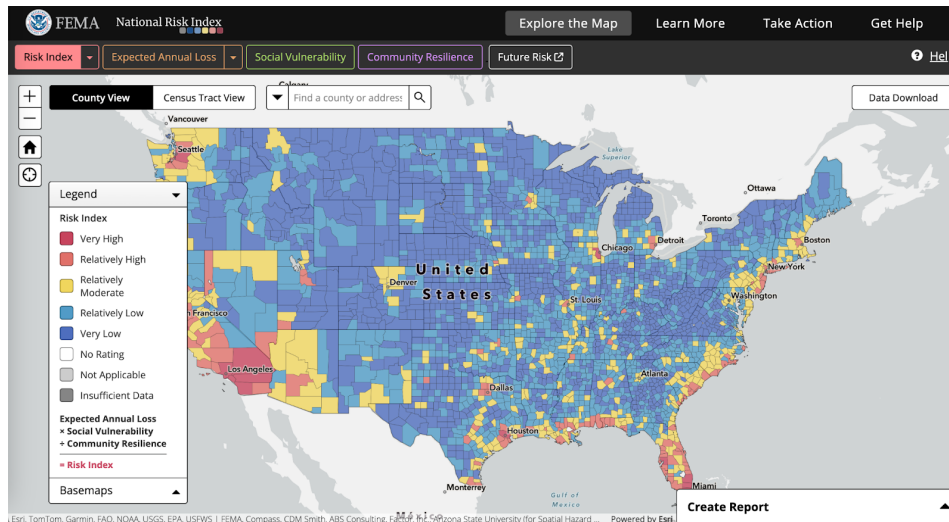


Figure X. FEMA's National Risk Index Map is shared as an interactive map and other interpretive products. <https://hazards.fema.gov/nri/> (accessed 18-Jan 2025)

Ensure data is reusable

The ability to integrate data from disparate sources is often undermined by inadequate data sharing and insufficient interoperability, resulting in significant time spent re-creating the same data sets. Spatial Data Infrastructures offer a solution to these challenges by providing online services for data discovery, evaluation, retrieval, and transformation. This allows for the reuse of data originally created for other purposes, which allows for attaining significant cost savings in system design and implementation.

The ability to use and reuse geospatial data is considered a key benefit of the National Spatial Data Infrastructure for the broader community of beneficiaries. Reuse may include using data in maps and apps, analyses, redistribution, and more.

Reuse means 'to use again or more than once.' (Oxford Dictionary) In this document, we usually use the terms use and reuse the same way. But when we use the term reuse, we mean using data for other reasons than what it was originally collected for. We also use the terms secondary use and downstream use, which we intend to be synonymous with reuse. (Zimmerman, 2008; Van de Sandt, 2019).

There are multiple conditions that foster reusability. Here, we focus on the characteristics of trust, reliability, and freedom from legal constraints.

Guidance: Share data that is easily reusable.

Reliable and persistent URLs

Trust is a fundamental requirement when utilizing geospatial data within a distributed ecosystem, ensuring users have confidence that the data will be consistently available when needed. It is essential that geospatial data is reliable, persistent, and reusable, instilling trust in users to confidently utilize the data for various applications. People and organizations rely on authoritative data for dynamic use in their own maps and apps.

URL—Keep the same URL if your data is updated

In Web GIS, a URL (Uniform Resource Locator) is crucial because it acts as the unique address to access and interact with geospatial data and services hosted on a server.

URLs allow users to easily retrieve maps, features, and perform analysis through a simple web link, essentially acting as the gateway to the geographic information within a web application. This enables seamless data sharing, integration with other systems, and dynamic manipulation of geospatial content through parameters embedded within the URL itself.

In a distributed geospatial ecosystem, trust can erode when web service and data layer URLs unexpectedly change, hindering the dynamic use and reuse of data in maps, applications, and distribution nodes. This instability can lead to a lack of confidence among users, impacting the reliability and persistence of geospatial data sharing within the ecosystem. If URLs change for a shared web data, the maps and apps that rely on that data layer no longer have access rendering them useless.

Best practice: Maintain persistent web services and data layers with unchanged service and item URLs.

Open data—Use an approved license

Providing an open data license is crucial for national priority data as it promotes transparency, encourages innovation, and facilitates wider access and use of critical geospatial information for societal benefit. [The following best practice should follow an FGDC endorsed open data license.]

Best practice: Use an approved open data license. Federal data providers *should* use an approved open data license with geospatial data, national priority datasets, and National Geospatial Data Asset (NGDA) data layers that are eligible.

Optimize data for discovery, usability, and AI readiness

The more data is used, the higher its return on investment. To help meet the objectives of the NSDI 2035 Strategic Plan, a subset of priority metadata elements can improve dataset optimization for the following cases:

- Discovery
- Usability
- AI readiness

When geospatial data is optimized for discovery, use, and AI readiness, it is easy to understand at a glance. Search-engine-optimized geospatial data is easy to find across a wide variety of channels in a national and global data ecosystem. This includes data catalogs, portals, content management systems, search engine results pages (SERP), and AI assistants.

Guidance: Optimize data following proven practices to facilitate discovery, usability, and AI-readiness:

1. Apply best practices for priority metadata elements
2. Identify authoritative data
3. Employ search engine optimization techniques

Apply best practices for priority metadata elements

Apply best practices for priority metadata elements to optimize data for discovery, use, and AI readiness, regardless of the specific metadata standard used.

Metadata element	Guidance	Best practice
Title	Optimize titles for discovery and AI readiness	Use concise, descriptive, and distinct titles. Follow the pattern: What (topic) of Where (location), and When (time period), if relevant.
Summary	Engage potential users and optimize for discovery	Provide a brief, engaging summary of the purpose and use cases for the content that will appear in galleries and search results, reaching broad audiences. Include keywords different from words in your title to increase findability and search engine optimization. Aim for between 120 and 250 characters and a 7th-9th grade reading level. Consider using a readability checker to assess reading ease.
Thumbnail	Capture attention	Add appealing preview images to engage users and help them understand content at a glance. Provide a preview image (600 x 400 or larger).
Description	Make it understood	Describe what your content is about. For example, a good description conveys "what" the data represents, "where" the data is located, "how" accurate it is, "when" it was collected, and "who" collected it.
Tags	Be specific	Provide at least 3 key word tags using narrower terms than in the title or summary to use in galleries and search results and increase the findability of the resource. Include complete spellings and common acronyms.
Categories	Make it sortable	Provide at least one ISO theme key word for browsing, search, and discovery.
Terms of Use	Communicate license and constraints	Include an open data license for eligible datasets. As needed, include general use limitations, restrictions, and constraints. Describe any terms or conditions to help users understand how the content should or should not be used.
Acknowledgments	Give credit	Provide a concise name of the data source to display in digital map attribution. Organizational abbreviations are appropriate.
Extent	Locate the data	Provide the geographic extent of the dataset content for search using bounding box coordinates in WGS84.
Attributes	Make it useful	Provide data attribute field display names and attribute field descriptions to ensure data are well-understood.
Status	Manage change	Include the lifecycle status of the dataset as it changes, for example, when deprecating content.

Identify authoritative data

[The following best practice should follow an FGDC-endorsed definition of authoritative.]

Datasets identified as authoritative build trust, help users know which is the correct dataset to use, and therefore reduce duplication. Some systems will use an authoritative tag to boost search results to optimize discoverability.

For example, original work may be identified as authoritative when it is:

- A dataset collected and maintained by the primary source organization
- A dataset collected and maintained by one organization and officially shared/distributed by another organization (e.g., under agreement with the source organization)
- An official dataset aggregated from other sources, for example, the National Address Database (NAD)

Best practice: National priority datasets *should be* identified as authoritative.

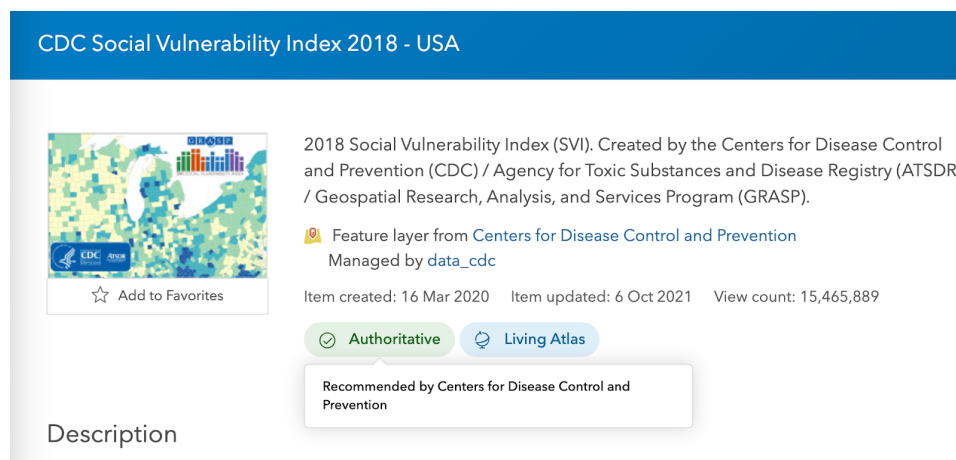


Figure X. The Centers for Disease Control and Prevention (CDC) recommends its content as authoritative to help build trust and increase usage. This data layer from the CDC has over 15 million views.

Employ search engine optimization techniques

Search engine optimization (SEO) is about helping search engines understand your content, and helping users find your content and make a decision about whether they should visit your site.

SEO data landing pages

Much like a webpage, datasets can be search engine optimized to help people discover your content. Best practices for priority metadata elements, such as title and summary, are part of SEO.

Guidance: Employ industry standard search engine optimization (SEO) techniques for datasets. For example:

- Have dataset landing pages.

- When possible, include the dataset title and publishing organization within the page URL.

Avoid duplication

Avoiding duplication is also important for geospatial data SEO. Avoid duplication to optimize sharing and discovery in geospatial ecosystems. Duplication makes it harder for users to find the source that best meets their needs. This is primarily because search engines usually rank duplicate content lower than a single source, but also because duplicate records make it harder for users to choose the appropriate source. (UK Geospatial Commission, 2020)

For example, North Carolina State Government GIS Users Committee members expressed concern over how difficult it was to find the correct authoritative dataset. That there were “too many identically named datasets showing up in search results,” was among their chief complaints. (Kiley 2024)

Guidance: Share authoritative data dynamically by connecting directly to the source.

- When subsets are needed, consider sharing dynamic subsets of authoritative data services rather than publishing new disconnected datasets.
- Follow best practices herein when redistributing authoritative data and derivative products.

Pursue AI readiness

New technologies like AI assistants offer new ways to make geospatial data easier to use. These technologies promise to make data sharing more efficient and user-friendly. The incorporation of these recommendations ensures that organizations can effectively leverage these advancements to optimize their geospatial data management processes.

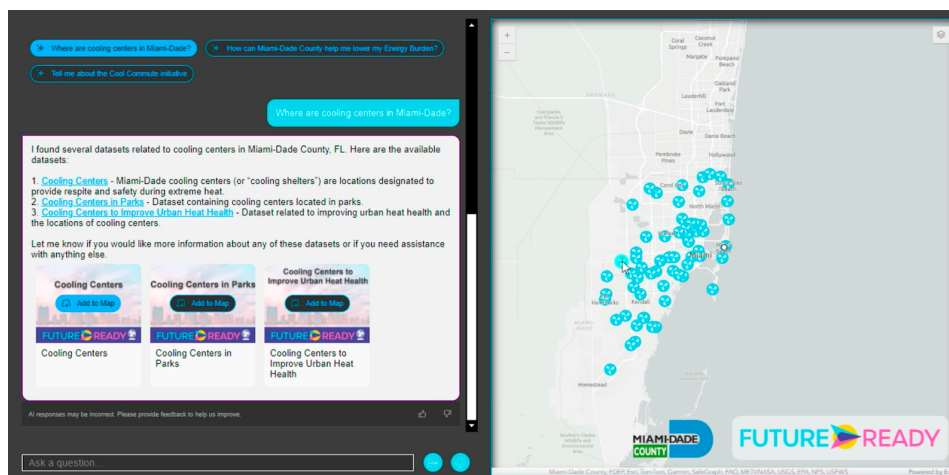


Figure X. Miami-Dade County, Florida, leverages the ArcGIS Hub AI Assistant to help residents locate cooling centers during extreme heat events. Esri User Conference: 2024

https://mediaspace.esri.com/media/1_fhmmwiur?kalturaSeekFrom=786&kalturaClipTo=977&kalturaStartTime=13 (video accessed 18-Jan 2025)

Archive data for posterity

Archiving data ensures that valuable geospatial data is preserved and remains accessible for future use. However, archiving datasets can be time-consuming, complicated, and expensive. Perhaps due to these challenges, most public agencies in the United States have not implemented systematic geospatial data archiving. Though not an easy task, the return on investment of historical geospatial data available for planning, research, and teaching is high – especially for examples such as longitudinal studies, case studies, and impact analyses.

Guidance: Systematic archiving of priority national datasets is a crucial practice in order to maintain access in perpetuity. Key recommendations include:

- Make a periodic copy of datasets to archive, while maintaining the URL of the actively shared content.
 - Frequency of archiving will vary based on the nature of the dataset and an organization's data governance.
 - Append a date to the title representing the time period of the content. Layer names without dates are assumed to be current. Dates represent the time period of the data. It is common to express the date as Year (YYYY), Year-Month (YYYY-MM), or Year-Month-Day (YYYY-MM-DD). (reference: ISO 8601 date/time format)
 - Work with experts in a given field to determine the appropriate archiving interval.
- Include appropriate metadata records in order to enhance discovery and future use.
- Designate agencies as being responsible for submitting data to the archive.
- Build a sustainable spatial data infrastructure that includes stored archival files and access copies.

Appendix B – Background: Fundamental challenges & actionable opportunities

Advancing the National Spatial Data Infrastructure

One of the primary challenges in data access and sharing between government departments lies in technical, policy, and legal barriers, with national security and privacy concerns being key obstacles. While technical solutions for interoperability are progressing, political and human factors, referred to as "human interoperability," hinder progress. Government departments often resist breaking down silos to protect their mandates, positions, and budgets, which limits the effective sharing of geospatial information and resources (UN-GGIM 2020).

As specifically stated by the United Nations (UN) report:

The lack of fundamental, standardised, up-to-date, and accurate data is one of the challenges holding back further advances. Many nations have experienced duplication as various stakeholders create data for their own purposes using different specifications and standards, data formats, and data redundancy, as well as using a different base map or source for data capture. Those involved in the implementation of NSDIs have experienced challenges aiming to avoid inefficient bureaucratic processes for the production, integration and sharing of fundamental data. (UN-GGIM 2020)

The UN-GGIM *Future Trends Report* (2020) proposed that the following areas should be the primary focus in the near term: “(1) **Improved exposure of spatial resources to the web** and creating a national framework to access open public data, including geospatial data; and, (2) **Redefining spatial resources’ metadata** and their production and their provenance.”

Research suggests that advancing SDIs will require expanding from human-readable data supply methods to machine-readable, on-demand capabilities, known as a Spatial Knowledge Infrastructure (SKI). SKI is defined as “a network of data, analytics, expertise and policies that assist individuals or organisations to integrate real-time spatial knowledge into everyday decision-making and problem-solving” (UN-GGIM 2020; Duckham, et al 2017).

The UN Integrated Geospatial Information Framework (IGIF) recognizes the shift from traditional Spatial Data Infrastructures (SDI) towards a "knowledge infrastructure." While building on the achievements of SDI and National SDIs (NSDIs), IGIF goes beyond just data collection and technology implementation. It addresses the limitations of traditional SDIs by focusing on the emerging data ecosystem, which relies on diverse, location-dependent data integration, and the need for flexible, timely, and interoperable data. Unlike conventional SDI approaches, which mainly focus on geospatial data, IGIF emphasizes developing geospatial capacity to support government functions. It also considers governance, policy, financial, education, and communication factors, which were previously overlooked by SDIs (UN-GGIM 2020).

SDI Opportunities for Specific Growth

1. Improved Web Exposure and Data Accessibility:

- a. Facilitate broader access to geospatial data through web platforms by creating a comprehensive national framework for open data.
- b. Ensure public datasets, including geospatial data, are easily discoverable and usable.

2. Redefining Metadata and Provenance:

- a. Improve metadata systems for spatial resources to enhance their description, production, and traceability.
- b. Establish clear protocols for data provenance to ensure reliability and trustworthiness.

Geospatial Knowledge Infrastructure

Similarly, the idea of Geospatial Knowledge Infrastructure (GKI) has been proposed as well:

GKI recognises the importance of the UN IGIF as the basis for nations to create, share and use geospatial information. But, as described, this is one part of GKI, which moves beyond this objective to joining it with industry thinking and the far wider digital ecosystem. (Geospatial World 2021)

The GKI model seeks to elevate location from additional information to critical information. As stated in the GKI Whitepaper, “GKI is an infrastructure to integrate geospatial approaches, data and technologies into the wider digital ecosystem” (2021). The follow-up report on GKI readiness ranks the United States as #1, but highlights some areas in need of improvement, including Integrated Policy Framework (specifically Geospatial Mandate in Sectoral Policies and UN-IGIF Adoption), Foundational Data (specifically Open & Linked Data), and Geospatial Dimension to Digital Infrastructure (specifically Standards) (Geospatial World 2022).

GKI Opportunities for Overall Growth

1. Integrated Policy Framework

- a. **Geospatial Mandate in Sectoral Policies:** Greater alignment of geospatial mandates within sectoral policies is required to strengthen integration and enhance their effectiveness.
- b. **UN-IGIF Adoption:** Broader and more effective adoption of the UN Integrated Geospatial Information Framework (UN-IGIF) is essential for improved governance, capacity development, and cross-sectoral collaboration.

2. Foundational Data

- a. **Open & Linked Data:** There is a need to improve the availability and accessibility of open geospatial data by establishing a robust national framework for open public data from all levels of government. Enhanced practices for linking geospatial data across domains are also necessary.

3. Geospatial Dimension to Digital Infrastructure

- a. **Standards:** Standardization in the geospatial sector is a key area for improvement. This includes developing and adhering to uniform standards for

data sharing, integration, and interoperability to support digital infrastructure effectively.

Proven practices

We've reviewed guidance and best practices gathered from organizations worldwide. Proven practices are backed up by evidence of real-world implementations. The guidance herein is based on these proven practices. It is supported by pragmatic best practices.

This report collates and provides evidence of proven practices. It offers technology-agnostic recommendations to be endorsed by FGDC, adopted and implemented by federal agencies, and promoted to the broader NSDI community.

Best Practices for Publishing, Retrieving, and Spatial Data on the Web, lays out several related principles including:

- Deliver benefits to the **broadest community** of Web users possible—not to geospatial data experts only
- Have a **broad focus** in order to promote a **linked data approach**
- The intention of the best practice is **not to create new solutions where good solutions already exist** or to invent solutions where they do not yet exist
- Best practices should **comply with the principles** of the W3C Best Practices for Publishing Linked Data and the W3C Data on the Web Best Practices

(Van den Brink, et al 2019)

Distributed data management

There is a general consensus that best practices exist in places, as stated by Sparks:

This “wheel” does not need to be re-invented, but simply de-constructed with the best practice pieces identified and reconstructed to create a new and improved wheel (Sparks 2014).

The paper details best practices for nine projects, programs, and initiatives. The conclusions focus on creating consistent, nationwide data by collecting information from local stewards and “rolling it up” to the state and federal levels. Data is freely downloadable and widely distributed, leveraging highly accurate, up-to-date local information without requiring changes to local data or business practices. The state provides financial support and facilitates collaboration between federal, state, and local partners. Additionally, it improves local access to federal funding, geospatial resources, and disaster response programs (Sparks 2014).

When it comes to best practices, there are many ways to achieve the goal of improving data discovery and access for public geospatial data across the nations. Here we offer two case studies for consideration, noting that these are not mutually exclusive options and could even work very well if implemented together.

Case Study: Funding Model

Consider something akin to the Wisconsin Land Information Program (WLIP) model. This is a program that earmarks government fees related to land information, and returns a portion of those monies, annually, to the land information producers.

In Wisconsin the funding takes the form of a register of deeds real estate document recording fees. These monies are administered by the Department of Administration and return over \$13 million annually to Wisconsin counties for the modernization of local land records (WLIP 2024). All 72 counties participate in the WLIP. The program is governed by state statutes [16.967](#) and [59.72](#), as well as [Administrative Rule Chapter Adm. 47](#).

According to [s.59.72\(5\)\(b\)\(3\)](#), Wis. Stats., and [Adm. Rule 47.06\(3\)](#), a county must spend Wisconsin Land Information Program funding (both fees retained and grants received) consistent with its county land information plan. County Land Information Plans must contain context on the counties land information program; explanation of how land records and GIS data are essential to the county and county services; details on how to achieve land information offices 3 year mission through concrete goals and objectives, and; project summaries. Exemplary work is being done across Wisconsin, driven by coordination through WLIP. The most recent report illustrated where counties utilized these funds for needed improvements (WLIP 2024).

This program could be a model for non-federal stakeholder work important to the NSDI vision of a truly integrated and interoperable geospatial ecosystem.

In a larger model there are many fees collected on federal lands and for federal business – examples include entrance fees for certain national parks and monuments, standard amenity fees for developed recreation areas like campgrounds and visitor centers, and special permit fees for activities like group use or motorized vehicle access; with the exact fees depending on the specific location and activity, and often managed under the Federal Lands Recreation Enhancement Act (FLREA).

Case Study: Collaborative Efforts

As funding for new efforts is often scarce, academic libraries "seek collaborative solutions, pooling resources across libraries to increase buying power; reduce duplication of efforts as well as duplication of collections; and enjoy economies of scale" in order to innovate (Tickner, et al 2024). Libraries in the Big Ten Academic Alliance Geospatial Information Network (BTAA-GIN), which operates the BTAA Geoportal, began their efforts in 2015. As of early 2025, the geoportal provides access to over 100,000 items including nearly 45,000 geospatial data sets (BTAA-GIN 2024).

The vast majority of the data sets are publicly available data produced by state, regional, county, and municipal governments. This aggregation allows for a single point of discovery for tens of thousands of data sets produced by dozens of government agencies across 11 states. The work of the BTAA-GIN also includes "metadata enrichment and normalization" which in turn improves discovery and access for public geospatial data (Tickner, et al 2024).

If this type of model were to be reproduced at a handful of institutions across the nation, the efforts could enable a "roll-up" of data that is accurate and local without requiring significant changes to current practices at the agencies that supply the data. There would be an investment required, but that would be at the regional level and could be led by academic libraries, with the possible added future benefit of archiving the non-Federal data, as the work of locating the data and creating or enriching metadata will already have been accomplished.

Metadata management

The FGDC has a solid foundation with regards to metadata management:

Metadata creation and management is a geospatial data management best practice...the Federal Geographic Data Committee (FGDC) has long promoted the creation of standardized geospatial metadata and recent legislation...specify critical roles for metadata. The GDA requires Covered Agencies to "include standards for metadata for geospatial data, and other appropriate standards, including documenting geospatial data with the relevant metadata and making metadata available through the GeoPlatform." Lead Covered Agencies are required to create and maintain "metadata for geospatial data within the National Geospatial Data Asset data theme." The GDA establishes the GeoPlatform, which is required to "include metadata for all geospatial data collected by covered agencies, directly or indirectly." Further, the GDA requires that metadata standards "to the maximum extent practicable, shall be consistent with international standards and protocols." (FGDC 2022)

The recommendations herein build on that work by identifying key use cases for metadata for the NSDI. It recommends best practices for effectively using priority metadata elements.

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