Summer 2024

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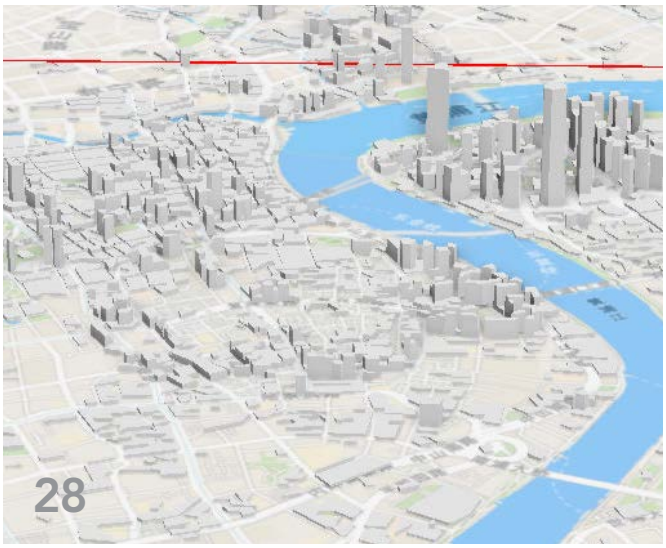

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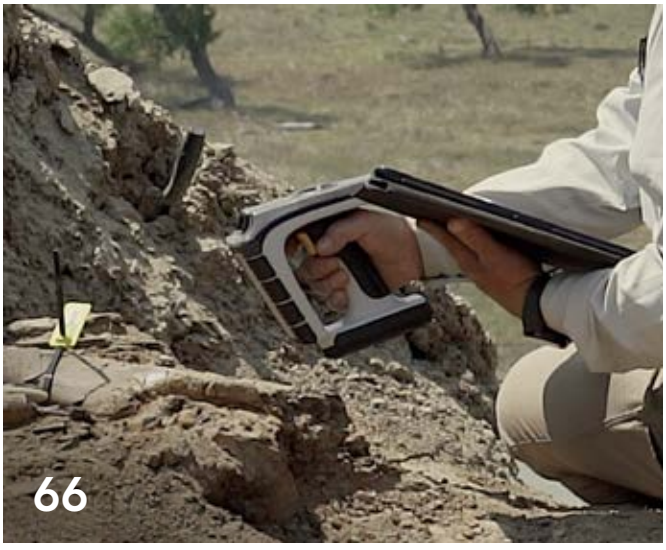

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Where Is a Powerful Thing

The technology for applying the geographic approach—GIS—is expanding our world. That was the message delivered by Esri president Jack Dangermond in his address during the Plenary Session of the 2024 Esri User Conference.

"Geography organizes everything we know—all our experiences," said Dangermond. "This magical word *where* is an extraordinary word because it connects all of humanity to all the science. The where is a powerful thing. It's your bridge to everyone else on the planet. It helps us see the world in interconnected ways."

Through its geospatial infrastructure, GIS is helping make those connections with data and analysis tools that are more accessible. It yields information that is available to more people and expands opportunities for collaboration and improves decision-making.

"Cloud-Based Approach Revolutionizes Interagency Data Sharing," an article in this issue, amply demonstrates the benefits of a geospatial infrastructure. The US Forest Service, the US Fish and Wildlife Service, and the US Geological Survey (USGS), are participating in the first cross-agency geospatial data sharing service that makes the most current versions of more than a petabyte of aerial imagery and raster datasets available in a very cost-effective and scalable fashion.

Geospatially-derived information is more available than ever because GIS tools are more powerful and enabling. AI-enhancements to ArcGIS Pro assist users in finding the right tools and suggest workflows that produce useful information in an expedient timeframe. These enhancements help experienced users as well as those new to the technology.

With the ArcGIS Maps SDK for JavaScript, developers can employ tools and techniques that let web apps and the information they furnish reach a wider audience including persons with low or no vision. Basemap options, color schemes for symbolizing maps, and alternative text options enable techniques that support accessibility to maps and apps across the ArcGIS system.

A holistic, GIS-based approach can help build a world that is environmentally, economically, and socially sustainable. This will require unity. And it won't be easy. In the words of Minnesota governor Tim Walz, the first keynote speaker at this year's Esri User Conference, "Uniting is much harder. Bringing people together is much harder. The tools of GIS and the science behind this and the tools to communicate really help unite people."

Monica Pratt
ArcUser Editor

ArcUser

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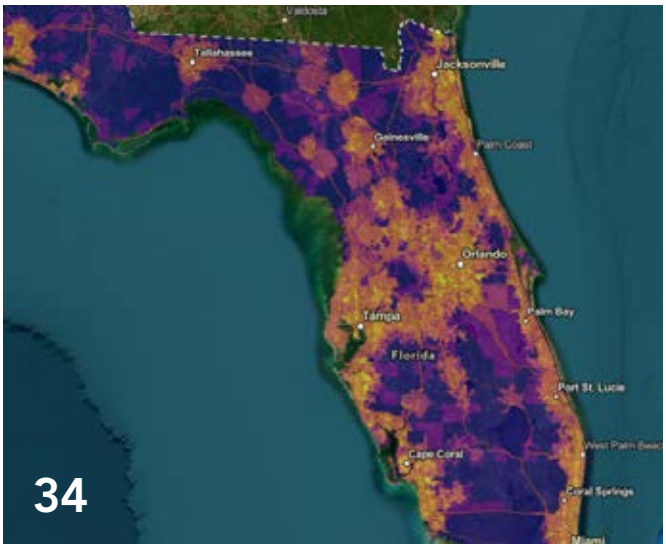

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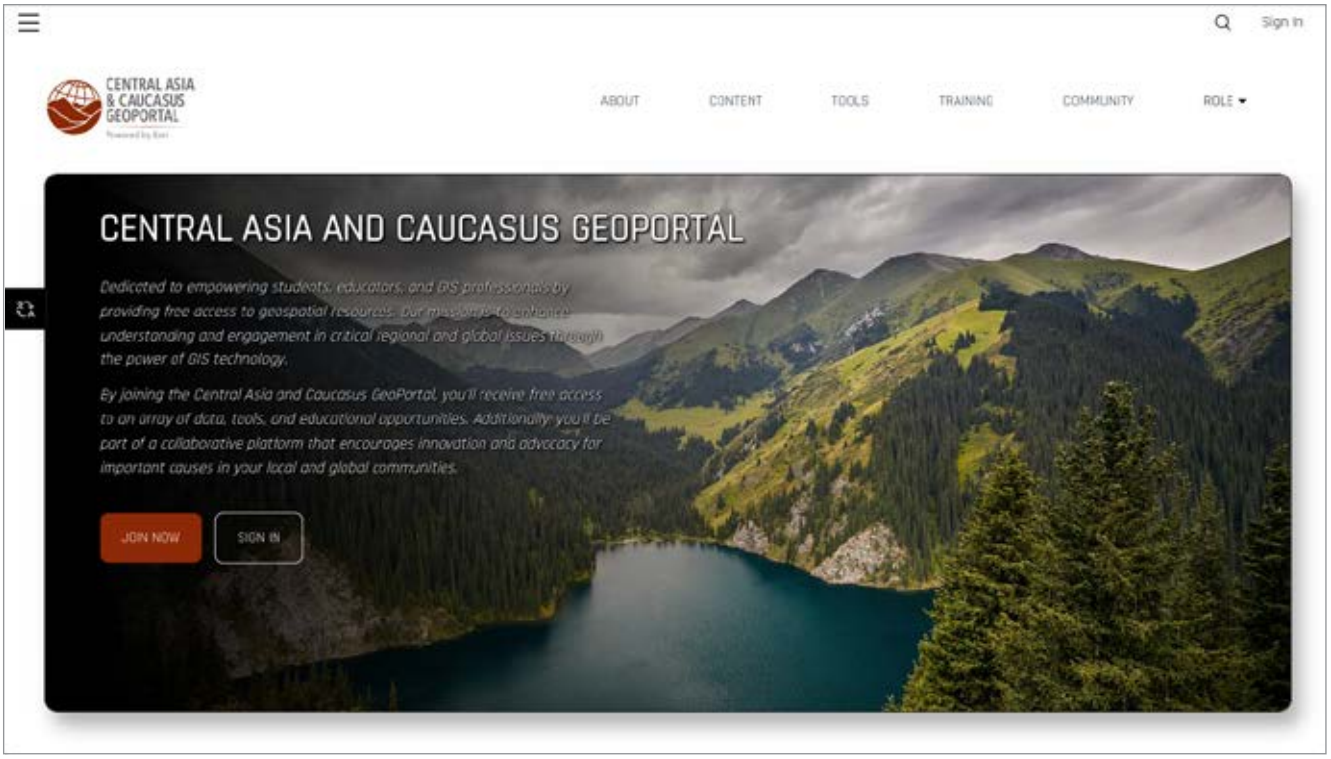
Briefly Noted

→ Esri Launches Central Asia and Caucasus Geoportal

The Central Asia and Caucasus Geoportal (www.cacgeoportal.com/) was launched by Esri in May 2024. It is the region's first free, collaborative GIS portal. It provides individuals with free access to data, GIS tools, and training resources. Users who sign up will be part of a collaborative platform that encourages innovation and advocacy for important causes in local and regional communities.

Many existing open-source and open data sites have been used to share data in the region but lacked the tools and necessary learning materials to fully engage with Esri's GIS technology. The Central Asia and Caucasus Geoportal will help community groups in the region and Central Asia Geospatial LinkedIn groups better understand regional issues, such as climate change, natural resource utilization, population growth, and conservation, using the power of mapping and analytics. The geoportal provides access to industry-leading spatial analytics capabilities and authoritative data, enabling users to more effectively collaborate and make better-informed decisions.

↓ The Central Asia and Caucasus Geoportal, launched by Esri, is the region's first free, collaborative GIS portal.



→ Latest Land-Cover Map Updated with Sentinel-2 Satellite Data

Esri, in partnership with Impact Observatory, released an updated global land-use/land-cover map of the world based on the most up-to-date 10-meter Sentinel-2 satellite data. This new data is available from ArcGIS Living Atlas of the World. The Sentinel-2 10m Land Use/Land Cover Time Series update includes new data from 2023 and expands the series to include global coverage from 2017 to 2023. Annual Sentinel-2 updates provide governments, businesses, and scientists with the most current land-cover maps to inform policy and land management decisions. Year-over-year changes shown by land-cover maps help analysts and decision-makers better understand the impacts of earth processes and human activity on the environment. In 2023, Esri released the Sentinel-2 Land Cover Explorer, a dynamic, ready-to-use online application that allows anyone anywhere to easily observe change on these high-resolution global land-cover maps.

↑↑ The Sentinel-2 10m Land Use/Land Cover Time Series update, available from ArcGIS Living Atlas of the World, includes new data from 2023 and expands the series to include global coverage from 2017 to 2023.

↑ Aggregated Armed Conflict Location & Event Data Project (ACLED) data is available as a layer, key indicator map, and web map from ArcGIS Living Atlas of the World.

→ Armed Conflict Data Available in ArcGIS Living Atlas

Researchers, journalists, risk analysts, corporate security managers, and governments can access a global, real-time data and analysis source of political violence and demonstrations around the world through ArcGIS Living Atlas of the World. The source of this data and analysis is the Armed Conflict Location & Event Data Project (ACLED), a nonprofit that collects information on the dates, actors, locations, fatalities, and types of all reported political violence and protest events around the world. The nongovernmental organization provides disaggregated data collection, analysis, and crisis mapping. It furnishes the highest quality and most widely used source of reliable information on current disorder patterns.

An aggregated ACLED data file is now available through ArcGIS Living Atlas of the World as a feature layer, a group layer of key indicators, and a web map with time configuration. The data is presented as counts by month for the past year, mapped to a centroid of the first administrative division (e.g., Province) as defined by ACLED. With these new resources, key conflict statistics can be visualized and analyzed over time to understand current global and regional patterns of conflict. While this aggregated data is available to all ArcGIS users via ArcGIS Living Atlas, fully disaggregated data (with some limitations) can be obtained by registering through the the ACLED website.

More Capabilities, Flexibility, and Scalability with **Updated User Types**

VIEWER

- Explore content.
- Access dashboards.

CONTRIBUTOR

- Review and apply simple edits.
- Collaborate with team members.
- Leverage enterprise integrations.

MOBILE WORKER

- Collect data from anywhere.
- Receive work assignments.
- Navigate routes online and offline.
- Access and share current data.

Esri's updated user types deliver secure, flexible, and expanded access to ArcGIS. By providing different levels of access to ArcGIS, they ensure that teams can employ the technology to collaborate efficiently and increase the reach of spatial capabilities across an organization. The updated user types are:

- **Creator**
- **Professional**
- **Professional Plus**
- **Viewer**
- **Contributor**
- **Mobile Worker**

From having access to more capabilities at each role level to streamlining licensing management, updated user types offer a range of benefits to organizations of all sizes. Organizations can extend the reach of their GIS by giving additional team members roles that allow them to collaborate with internal content and continue to provide public access to maps and open data.

Capabilities Aligned to Team Roles

User types provide each team member with role-based access to the ArcGIS capabilities, apps, and content they need to do their work. For example, team members who create content can map, analyze, and manage data to share with collaborators, who can then view it and make simple edits for accuracy.

More Flexibility in Working Environment

Whether users are working in the office or in the field, they can seamlessly use and update ArcGIS content across desktop, web, and mobile devices.

Streamlined User Type Administration

Users can be confident that their organizations are equipped with the necessary tools for success. ArcGIS capabilities, apps, and content that were once purchased and provisioned separately are now included in user types.

Scale as Needs Grow

It is now easier to add user types to an ArcGIS organization. With the updated ArcGIS user types, organizations can progressively expand their capabilities as needed. Users simply move to the next level to obtain additional capabilities.

Explore Esri's Updated User Types

Users who need to map, analyze, and manage data can choose from among the Creator, Professional, and Professional Plus user types. Each of these user types delivers access to a complete GIS, with more advanced capabilities available at each successive role level. These user types are a common place for users to get started, regardless of whether they're working in ArcGIS Online, ArcGIS Enterprise, or

ArcGIS Pro. They offer flexibility as an organization's needs grow by allowing users to move up to the next level, add on apps and extensions, and incorporate additional user types.

Produce and Share Content

The Creator user type is the entry point for accessing the essential capabilities of ArcGIS to produce dynamic maps and share content across an organization through a variety of prebuilt apps. Creator users can grant access and manage groups, members, and content, facilitating smooth collaboration. They can also enable an organization's mobile workforce by assigning tasks and managing work assignments. The updated Creator user type replaces the previous Creator and GIS Professional Basic user types and includes everything in the Mobile Worker user type except location sharing. Creator now provides access to ArcGIS Pro Basic, making Creator the foundational role for accessing ArcGIS capabilities in desktop and web environments.

CREATOR

- Create and share maps and apps.
- Perform basic analysis.
- Access ready-to-use data.
- Grant access to and manage members.
- Distribute work assignments.
- Access ArcGIS Pro Basic.

The Professional user type provides access to advanced editing, analytics, and data management capabilities across ArcGIS. With Professional, users can create and configure utility networks and parcel fabrics to manage mission-critical systems of record. The Professional user type replaces the GIS Professional Standard user type. It includes access to ArcGIS Pro Standard and everything in Creator.

The Professional Plus user type enables users to create production-ready cartography, make GIS 3D, and perform comprehensive analysis that scales to big data. Professional Plus users can leverage machine learning and deep learning models to perform end-to-end AI workflows. The Professional Plus user type replaces the GIS Professional Advanced user type. It now includes access to ArcGIS Pro Advanced, the most popular ArcGIS Pro extensions, and everything in the Professional user type.

Support Organizational Needs

The Viewer, Contributor, and Mobile Worker user types support specific internal organizational needs.

The Viewer user type allows users to securely view their organization's maps, apps, and dashboards so that they can make better decisions and monitor internal key performance indicators (KPIs) and status updates.

The Contributor user type leverages enterprise integrations to ensure that organizations operate with the most up-to-date information. It empowers users to review data, make simple edits to it, and collaborate on projects using a variety of data. The Contributor user type includes everything in the Viewer user type.

PROFESSIONAL

- Perform advanced data editing and management.
- Configure utility networks and parcel fabrics.
- Do additional analysis.
- Access ArcGIS Pro Standard.

The Mobile Worker user type allows organizations to streamline office-to-field connectivity with secure field apps that help users efficiently receive work assignments, update data, navigate routes both online and offline, and share their location. The Mobile Worker user type includes everything in the Contributor user type.

Everything in Viewer, Contributor, and Mobile Worker user types is included in the Creator, Professional, and Professional Plus user types except location sharing. The Location Sharing user type extension is included with Mobile Worker and can be added to Creator and higher-level user types.

What This Means for Users

The updated user types for ArcGIS Online and ArcGIS Enterprise are available to purchase. For those who already have user types, here is how the updates are rolling out:

ArcGIS Online—Users automatically received updates to user types, including new capabilities and apps with the June 2024 update.

ArcGIS Enterprise—Users will see the updated user types when they upgrade to ArcGIS Enterprise 11.4, which is expected in Q4 2024.

Users on older releases of ArcGIS Enterprise will see the updated user types on quotes and renewals and will continue to receive the old user types until they upgrade to ArcGIS Enterprise 11.4 or above. Additional instructions on how to access the new capabilities will be provided in the ArcGIS Enterprise 11.4 release communications.

Esri has delivered ArcGIS Pro Basic to all users on ArcGIS Enterprise 10.9–11.3 who purchased Creator user types—or received Creator entitlements that were included as part of the ArcGIS Enterprise purchase—for the duration of their maintenance or subscription term. Because ArcGIS Pro can be administered through ArcGIS Enterprise or ArcGIS Online, the updates will be reflected in the respective releases.

GIS Professional user types will be converted to the updated user type and provide access to the equivalent license level of ArcGIS Pro. For users who have purchased an ArcGIS Pro add-on license, that license will remain active until that ArcGIS Online subscription or ArcGIS Enterprise license is renewed. Any Creator user types that are part of ArcGIS Desktop entitlements will continue to be delivered with the corresponding ArcGIS Pro add-on license.

Learn more at **go.esri.com/usertypes2024** or contact your Esri representative.

Understanding the Location Services System Pattern

The ArcGIS Well-Architected Framework provides IT and GIS professionals with a comprehensive set of ArcGIS system patterns to assist in designing an effective system tailored to an organization's needs.

This article takes a deep dive into one of these patterns to help you better understand the basics of system patterns. The location services system pattern enables the delivery of ready-to-use, location-based services for enterprise-wide and public use. This introduction will provide the key characteristics, user personas, applications, capabilities, and architecture considerations of this pattern.

The location services system pattern serves as a foundational system that delivers a range of location-based capabilities to all parts of an enterprise. These capabilities include basemaps, geocoding, routing, and spatial analytics. It provides authoritative, foundational geospatial content and capabilities to maps, applications, systems, and workflows within an organization. By centralizing the operations and management of core location services, this pattern ensures that location-based services are delivered consistently and efficiently.

The location services system pattern brings value to organizations by

- Delivering foundational geospatial content that is authoritative and capabilities that support the workflows and applications within an organization.
- Centralizing operations and management of core location services, ensuring efficient delivery and maintenance of these services. Centralization also builds trust in data quality as relevant data processes can be defined and implemented once, with consistent and observable results.
- Exposing standards-based service APIs that can be integrated into any system or workflow using an organization's preferred software development kit (SDK).

Organizations commonly leverage a combination of services that are hosted and managed by Esri (e.g., software as a service [SaaS] or platform as a service [PaaS]; services hosted and managed by other organizations; and services hosted within the organization in its own location services system, such as assets or customer locations.)

Organizations in industries from transportation and logistics to utilities and governments at all levels—national, state, and local—can leverage the location services system pattern to enhance decision-making, optimize operations, improve service delivery, and protect people and property.

Transportation and logistics companies leverage location services with their customer data to optimize delivery services by incorporating weather, traffic, and customer details to optimize package delivery. Esri-provided location services, such as network analysis, can optimize last-mile delivery to improve customer service and better allocate resources.

Esri-provided location services enable state governments to leverage GIS to help evaluate and prioritize infrastructure projects based on key criteria including safety, congestion, accessibility, and economic development. State transportation officials collect data and use it with Esri-provided location services to power a live dashboard that help make better informed investment decisions.

The location services system pattern within the ArcGIS Well-Architected Framework provides organizations with a robust foundation for delivering location-based services. Whether it's creating maps, analyzing spatial data, or optimizing routes, the location services system pattern plays a crucial role in building effective ArcGIS systems.

Learn how to build your location services system or read about other ArcGIS system patterns in the **ArcGIS Well-Architected Framework** at **links.esri.com/WAF.**

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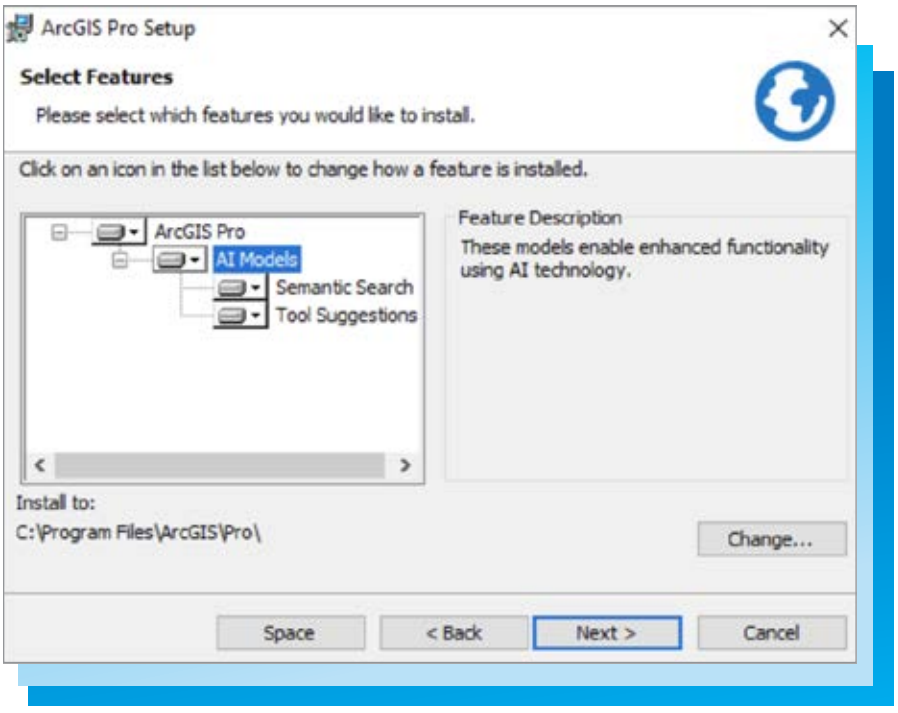
AI-Enhanced User Experiences in ArcGIS Pro 3.3

By Margaret Crawford, Drew Flater, and Jonathan Neal

ArcGIS Pro has a comprehensive suite of tools, including more than 2,000 geoprocessing tools in 40 toolboxes. Choosing the right tools for any analysis or data processing task is easier when you have a good understanding of what's available. But no one can be an expert on all tools.



↑ Select the AI features you would like to enable during installation.

That's why in ArcGIS Pro 3.3, Esri introduced new AI-enhanced experiences to help you find the right tools to perform your geoprocessing workflows. The tool search is now smarter with a semantic search engine, and you will receive tool suggestions after you run a geoprocessing tool, helping you get to the next step and complete your workflow.

This article will share information about these new features and how to get started with them in ArcGIS Pro 3.3.

Installing the AI Models

AI technology has the potential to make GIS analysts and others more efficient when using ArcGIS Pro, but some users and organizations may feel hesitant about this technology. So, in ArcGIS Pro 3.3, these new features are only available to those who opt in during installation.

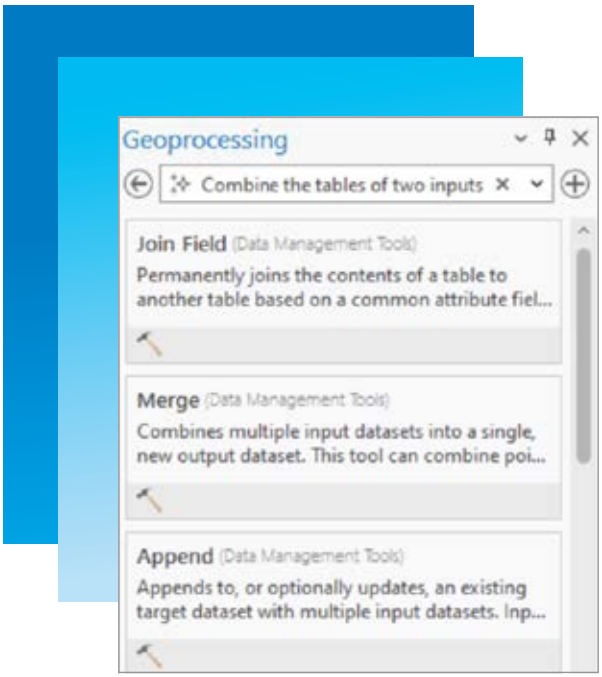
You can choose to install these features on the Select Features page of the ArcGIS Pro Setup dialog by clicking the drop-down next to each AI model. If you've already installed ArcGIS Pro 3.3 and missed the AI features, don't worry, you can still install them. In the Windows control panel, select Uninstall a program, then select ArcGIS Pro from the list of applications and click Change. You'll get the ArcGIS

Pro installation dialog with the option to modify the installation and enable the desired AI models.

Semantic Search

Semantic search is a smart search engine technology that can recognize the intent or meaning behind a query. Standard search engines simply find partial or complete matches between a search query and a body of text being searched. A semantic search engine supports searches using conversational or natural language and understands connections between related words with similar meaning.

For example, if you type "Combine the tables of two inputs" into the Geoprocessing pane's search bar, you will receive relevant results such as Join Field, Merge, or Append.



← An example of the top three search results returned from a query that used semantic search.

Semantic search is a foundation of AI technology and works by transforming text into a meaning vector (or an embedding). A meaning vector is a numeric representation that describes the text using the many dimensions or aspects of semantic meaning in language. The semantic search engine compares your search query to a database of meaning vectors to find the tools that most closely match your search.

The first time you start ArcGIS Pro 3.3, it will take a few minutes to build the embeddings database for all geoprocessing tools. Don't worry. This happens in a background thread, so you can still perform other tasks, including searching for geoprocessing tools using the standard search engine. When the semantic search engine is ready to use, the icon in the search bar will be enabled.

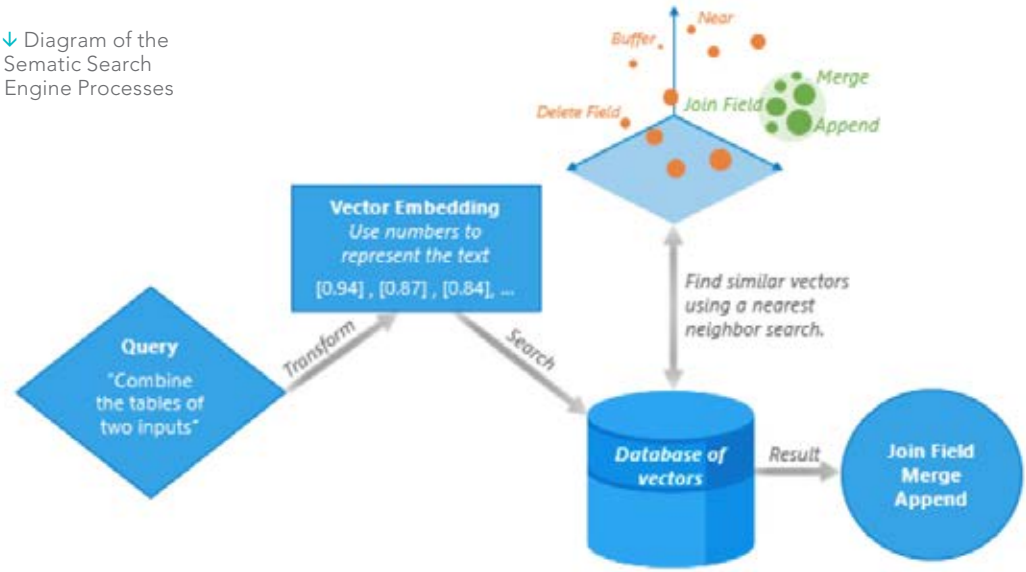
Note: Semantic search is not an AI chatbot or assistant. It cannot provide workflow steps or answer general questions. It will return search results with the tools most closely related to your query.

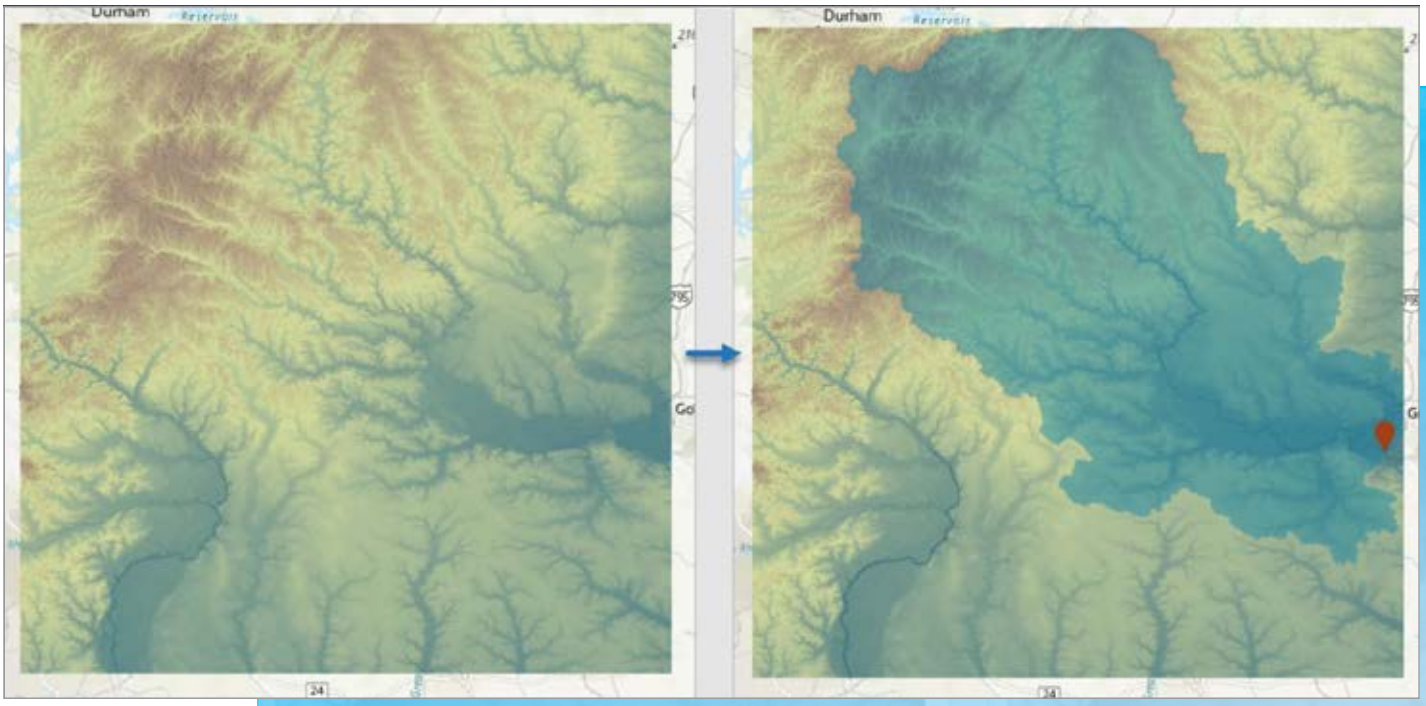
Tool Suggestions

Have you ever started an analysis, then wondered which tool you should use? New in ArcGIS Pro 3.3, geoprocessing tool suggestions are provided after you run each tool to help you get to the next step and complete your analysis. You can find tool suggestions on the tool status banner and the Geoprocessing pane Favorites tab.

To provide tool suggestions, the ArcGIS Pro development team created a sequence prediction model for geoprocessing tools. The model is trained using hundreds of thousands of tool usage logs from ArcGIS Pro users that participate in the Esri User Experience Improvement (EUEI)

↓ Diagram of the Sematic Search Engine Processes





↑ When delineating a watershed from a digital elevation model (DEM), the tool for the next step will be suggested. By following tool suggestions, you can complete this workflow in less time.

program. The model predicts the next tool you may want to use based on the tools you've already run in your project, which are logged in your geoprocessing history. Suggestions automatically update every time you run a tool.

If none of the suggestions are relevant, you can click Try Again to generate alternative suggestions.

Note: When you click a suggestion on the tool status banner, the tool opens on a new tool tab. Switch between open tools using the Add button in the upper right corner of the Geoprocessing pane.

Summary

ArcGIS Pro 3.3 includes AI-enhanced user experiences to help you find and run the right geoprocessing tools for your job. The improved semantic search engine gives better results that match the meaning of what you search for using conversational or natural language. And when you run a tool, you will get suggestions for the next tool you might want to use to streamline your geoprocessing workflows. These new features will help you benefit from the power of AI technology to make your use of ArcGIS Pro more productive than ever.

For further information, please visit the What's New in ArcGIS 3.3 documentation web page (links.esri.com/whatsnew3-3) and post your questions in the ArcGIS Pro board in Esri Community (links.esri.com/procommunity).

What's Next for AI Technology in ArcGIS Pro

The ArcGIS Pro development team is working on many other areas that incorporate AI

technology. These may include but are not limited to the following:

- Enabling the semantic search engine for command search
- A help chatbot that can answer questions based on ArcGIS Pro documentation
- Coding assistants to aid in writing SQL and openCypher queries, ArcGIS Arcade expressions, and Python code
- An assistant to help you plan workflows and run ArcGIS Pro functions using natural language prompts

Learn more and share your thoughts about these plans from the **ArcGIS Pro road map** on the Esri Community site (**links.esri.com/pro3-3roadmap**).

About the Authors

Margaret Crawford is a product engineer on the Esri geoprocessing team. Her passion for GIS began with her interest in human-environmental relationships, and her graduate studies utilized spatial analysis to study the growing impact of flood-induced cascading disasters caused by sea level rise. She leverages her foundation in research methodologies and spatial analysis techniques in her role at Esri, where she creates written content and demonstrations on technical concepts and functions in ArcGIS Pro. She also contributes to refining and redesigning geoprocessing tools and functions with additional capabilities and improved usability. In her personal life, Crawford is a loving parent to three cats and enjoys swimming and snowboarding.

Drew Flater is a group lead product engineer for the geoprocessing development team at Esri. He leads and contributes to projects across ArcGIS products with a focus on ArcGIS Pro. He joined Esri in 2008, after completing his master's degree in GIS at the University of Akron. Now he designs, codes, tests, and documents tools that can be used to understand and find meaning in raw geospatial data. He works to make geoprocessing and analytical capabilities easy to use and automate.

Jonathan Neal is a senior product engineer at Esri, working on the spatial analysis and geoprocessing capabilities of ArcGIS.

Cloud-Based Approach Revolutionizes Interagency Imagery Sharing

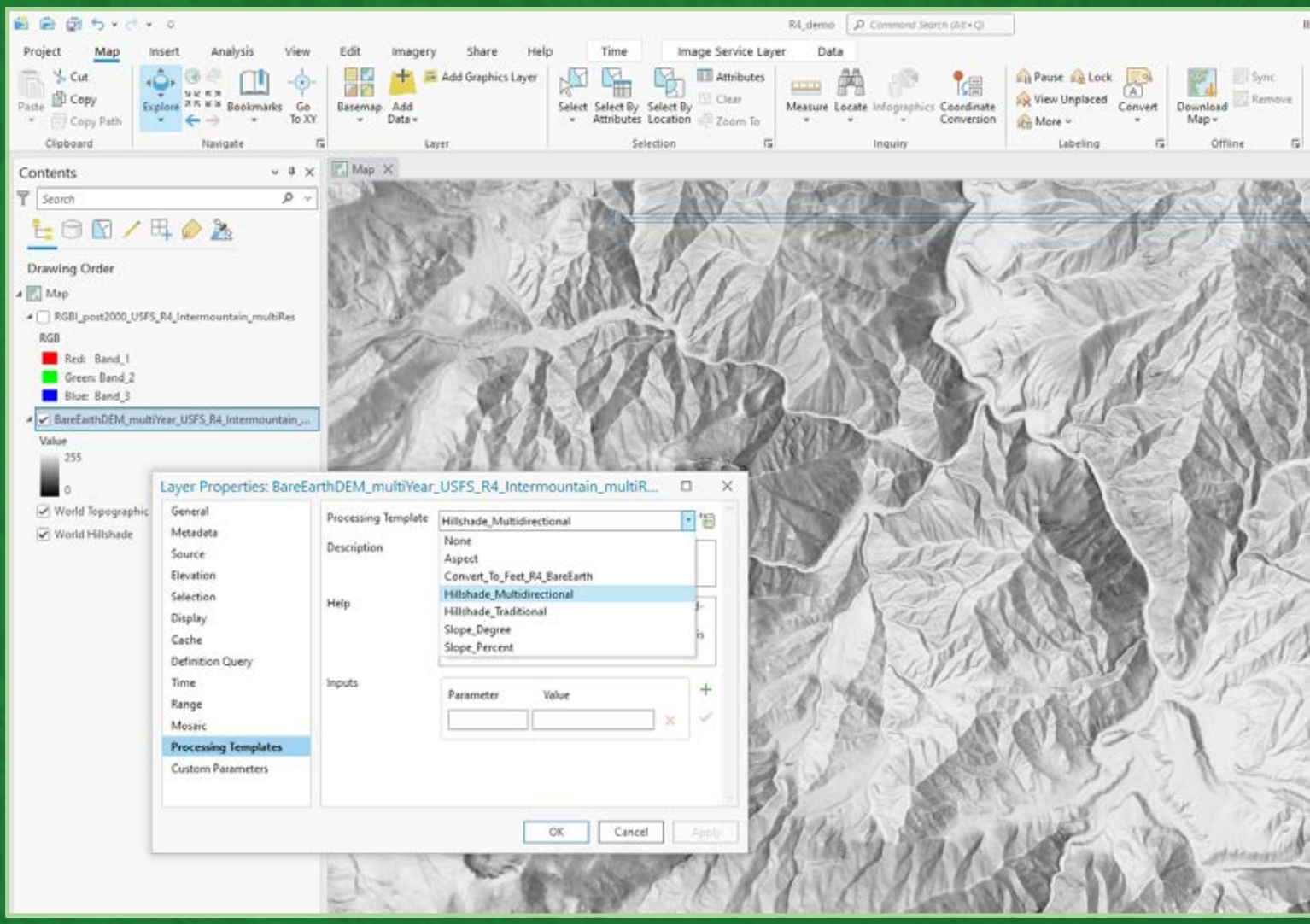
By John Steffenson

The US Forest Service spearheaded an effort to increase access to its trove of more than a petabyte of aerial imagery and raster datasets. This culminated in a cross-agency geospatial data sharing service that provides cost savings, increases capacity, and delivers more efficient data management of high-resolution aerial imagery and raster data.

For 20 years, the US Forest Service has served high-resolution aerial imagery to more than 12,000 people who use GIS technology to analyze images to answer questions about forest health.

Imagery has helped the Forest Service revolutionize the way forests are monitored and managed, including detecting pests and diseases earlier, assessing habitats for endangered and threatened species, conducting research of forest dynamics and ecosystem processes, and monitoring and managing wildfires.

A recent move to a new data center resulted in an unsustainable 1,300 percent cost increase, which left Forest Service administrators searching for a way to continue to use imagery to enhance operations. Instead of searching for ways to lower the cost, imagery experts had an idea. What if they could team with other federal



agencies to make the leap to the cloud?

They reasoned that a cloud approach could eliminate data duplication across agencies while unlocking new capabilities. It could also help agencies make the best use of the pipeline of high-resolution imagery the federal government procures from a network of providers.

"At the start of this, we had a feeling of skeptical optimism," said John Gillham, a contractor working as a project manager for the Forest Service. Gillham and Dave Vanderzanden, enterprise data and services program leader at the Forest Service, originated the project at the US Forest Service's Geospatial Technology and Applications Center. The duo reached out to geospatial administrators at various federal agencies and received guarded enthusiasm for the concept. Their queries revealed a widespread dissatisfaction with current imagery hosting options and a desire to use more imagery to understand landscape changes across the country.

With support from the Forest Service, the US Fish and Wildlife Service, and the US Geological Survey (USGS), the first cross-agency geospatial data sharing service—the Interdepartmental Imagery Publication Platform (IIPP)—launched in May 2024.

Rob Dollison, *The National Map* (*TNM*) delivery services lead at USGS, related how IIPP has provided a learning opportunity for all. "We've been able to share the process of building an image service in the cloud, and the Forest Service has done a lot to organize and host historical imagery," he said. "We each brought expertise to the table."

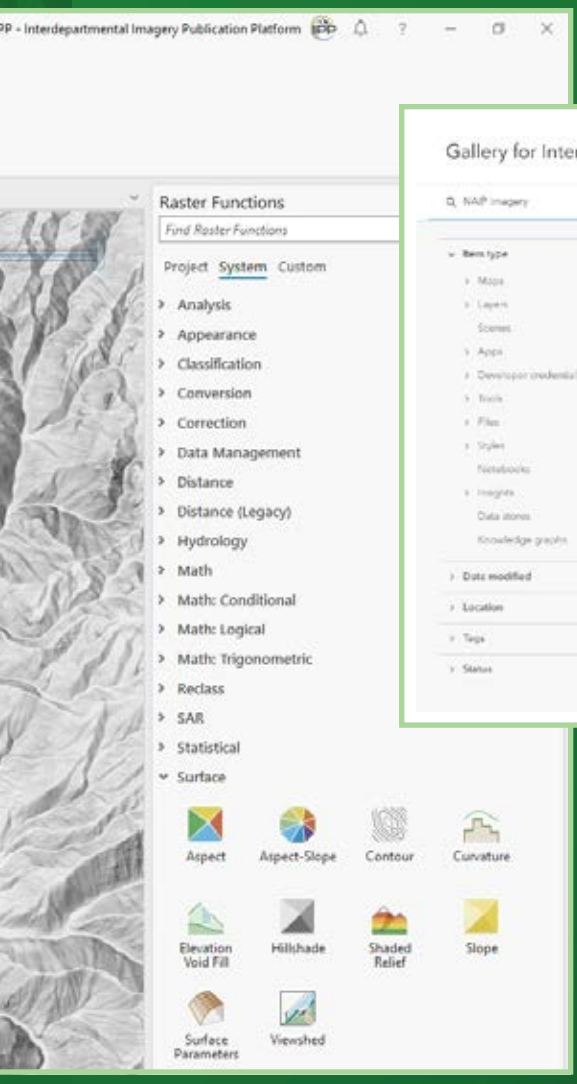
Advantages of the Cloud

The government's cloud-first pledge, and innovations in cloud-native technologies, finally made it feasible to create a shared data source for imagery. With the cloud, each agency can maintain control of its own data while gaining access to a larger trove of imagery for its users in this collaborative system.

"Interestingly, the cloud-first strategy wasn't our top consideration when we started four years ago," Gillham said. "We did an exhaustive analysis of 10 different hosting environments and scored those against eight criteria. The cloud popped out as the topmost viable option for cost-effectiveness, capability, and expandability."

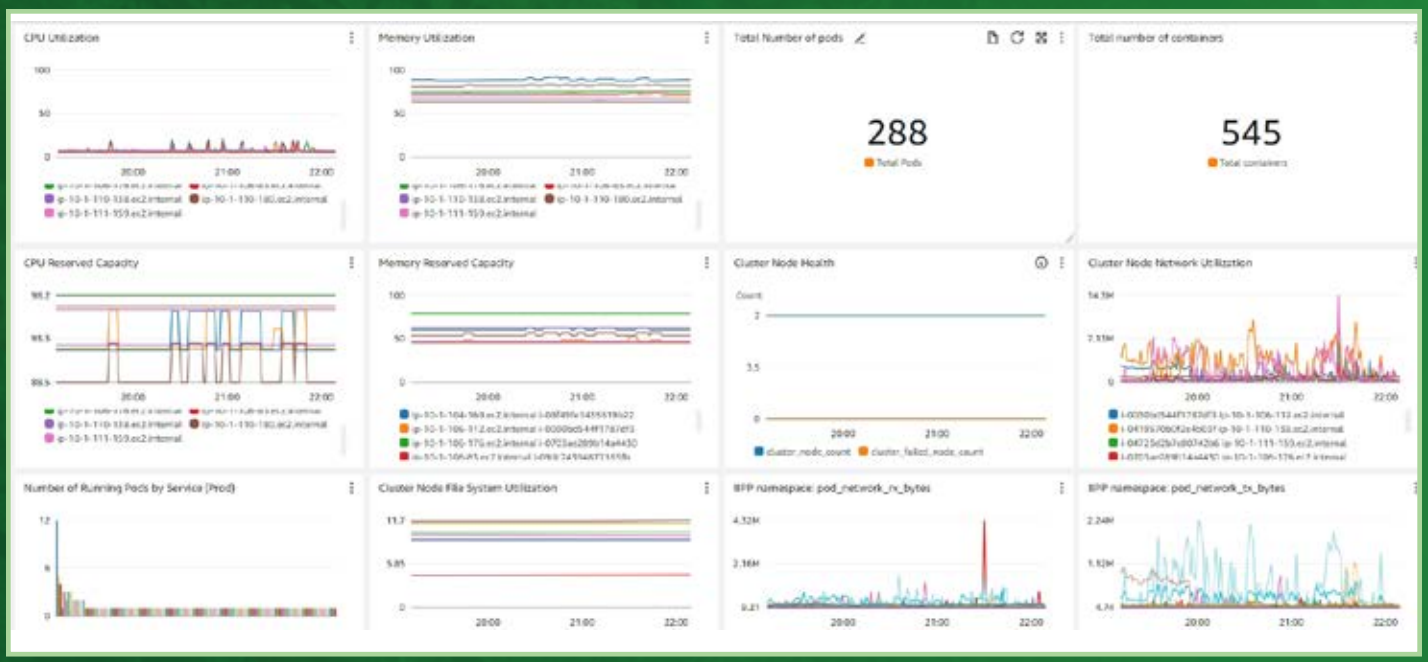
The IIPP site is hosted on Amazon Web Services using Esri's ArcGIS Enterprise on Kubernetes. Its cloud-native architecture scales quickly based on demand.

"Kubernetes helped us design a system that doesn't cost more than necessary when it's not in use, and it can handle an onslaught of anywhere from 12,000 to 50,000 users," Gillham said. In a recent test of its dynamic scaling capabilities, a new server was automatically added within



↑ The new NAIP_Plus service, one of the NAIP services available for many years, is wall-to-wall NAIP imagery for the contiguous United States, Hawaii, and Puerto Rico.

← The bare earth digital elevation model (DEM) service from IIPP with the on-the-fly processing template turns the layer into a multidirectional hillshade service in ArcGIS Pro.



seven minutes to meet a spike in demand.

The containerization approach of Kubernetes reduces the technical complexity of the system by bundling the code and dependencies needed to run it, which makes provisioning a new server automatic and quick.

"There's just nothing else out there that can do that," Gillham said. "We're going from a system that would take two months to get another server added compared to under 10 minutes now for as many servers as we need to meet the demand, all automatically."

Kubernetes also allows agencies to maintain full autonomy in a shared system. "We come from a publishing group ourselves that hosts data, and the last thing we want is to lose access and control," Gillham said. "When we reassured everybody that IIPP partners maintain full autonomy over their data, it helped relax some concerns and more agencies became interested."

A Platform for Sharing and Consuming Imagery

The typical pattern has been for each agency to host its own copy of the same data. During the scoping process for IIPP, the team found that six agencies hosted duplicate sets of the high-resolution images that the US Department of Agriculture collects for the National Agriculture Imagery Program (NAIP). Since 2004, the Forest Service has served all NAIP imagery, which amounts to half a petabyte of imagery.

Discussions have been ongoing with the Farm Production and Conservation (FPAC) Business Center, which processes and shares images through its Geospatial Enterprise Operations (GEO) division. FPAC GEO had coincidentally been making a migration to Amazon Web Services too, which makes further efficiencies possible.

"When their NAIP data becomes cloud optimized, we're hoping FPAC GEO will be able to make it available to us, at which point we can eliminate our copy," Gillham said. "When we're connected directly to FPAC source data, then the minute they update that data it's instantly updated for all of our users. That's an efficiency government should always strive for."

This cloud-to-cloud data sharing switch illustrates the efficiency gains that increase imagery sharing. It not only removes the cost of storing imagery more than once but also reduces labor costs to manage the data at each agency.

The IIPP team has been talking with nine federal agencies to answer questions and address past data- and cost-sharing challenges. An IIPP governance charter has been established to define roles and responsibilities, and a working group sets standards for how data is published and used. IIPP has a publishing tier for agencies that want to host data, and a consumer tier for agencies that want access to published datasets.

The three founding agencies have begun publishing data to IIPP and are planning rollouts to their users. By the end of 2024, the aim is to have all users on board and to begin to welcome more agency partners.

In addition to unlocking access to streaming imagery for all agencies, the hope is that more agencies will be compelled to publish and share their own datasets with the wider community. "With this joint shared system, we've lowered the cost and learning curve to get into publishing, especially in the cloud." Gillham said.

Gaining Interest Among Agencies

The first goal of reducing the cost of hosting imagery has been achieved. Next, IIPP aspires to expand its imagery serving service to all interested federal agencies. State government partners may be next, and public access has been discussed.

← This dashboard, located in the Amazon cloud, shows system health and stability by monitoring system utilization metrics for the IIPP Kubernetes cluster.

"The minute we cut over to the new system and turn the old system off, the Forest Service stands to save about $5 million per year," Gillham said. "We hope that each partner should also see a cost reduction to some degree, and the more partners that join this imagery hosting co-operative, the cheaper it becomes for everybody. This is just the beginning."

Given its status as the first interagency data hosting solution, IIPP has gained a lot of attention. "There were some skeptics in the beginning," Gillham said. "And as we keep progressing and getting over hurdle after hurdle, I think we've garnered more support and excitement."

Continuous effort will be made to refine and enhance the system based on user feedback and technological advancements. The promise of this cloud approach goes well beyond an easier and cheaper imagery serving system. Ultimately, it's about better answers.

"For years, these systems have been siloed so one agency couldn't access the other agency's data or images or each other's expertise," Gillham said. "I foresee a time when somebody applies a deep learning model or processing algorithm that another agency developed that suddenly solves a pressing problem they struggled with. That's the power of a collaboratively shared hosting system."

About the Author

John Steffenson is a manager for the national government sector at Esri, where he has held various natural resources roles since 1995. He works closely with the US Forest Service and the wildland fire community. Prior to working for Esri, he spent 15 years with the US Forest Service and a year at the US House Interior Committee. He holds degrees in forestry and geography and has nearly four decades of experience applying geospatial technology in solving natural resource problems. He sits on the board of directors for the National Museum of Forest Service History.

THE EVOLUTION OF SHARED SERVICES ACROSS GOVERNMENT AGENCIES

Shared services, such as hosting and delivering imagery, allows standardized and scalable operational tools to be delivered across agencies, which improves services, eliminates redundancy, and reduces costs.

The idea of services shared across government agencies has been on the United States Office of Management and Budget's agenda for more than 20 years. Beginning with the 2003 budget of President George W. Bush, a voluntary initiative focused on lines of business aimed to consolidate common functions across agencies. Under the Obama administration, shared services took on the designation of a Cross-Agency Priority Goal, with the most notable example being the Department of Housing and Urban Development transitioning some financial operations to the Treasury Department. The Trump administration emphasized modernizing government to deliver more effective services. Under the Biden administration, shared services have been integrated into broader goals of strengthening the workforce and ensuring access.

In the geospatial sphere, the efforts of the Federal Geographic Data Committee (FGDC) to cultivate and facilitate the National Spatial Data Infrastructure has an element of cross-agency data sharing. The Geospatial Platform (geoplatform.gov), a cross-agency collaborative effort that fosters open government, accountability, and transparency, provides a massive catalog of geospatial data, services, applications, and tools delivered as open data for everyone.

The Interdepartmental Imagery Publication Platform (IIPP) differs from an open data site in its delivery of integrated data to create a comprehensive national coverage of imagery that leverages the existing programs and resources that acquire it. IIPP consolidates imagery and creates a community of imagery users who can see and share data, tools, and algorithms with one another. IIPP's ultimate goal is serving imagery across all levels of government.

SMALL WATER DISTRICT ACHIEVES COMPLIANCE AND IMPROVES OPERATIONS

In 2022, the Littlerock Creek Irrigation District (LCID) in California began developing a new GIS program that would allow the district to comply with new state requirements while building an asset locations database and sharing location information with its operations staff.

↑ LCID serves 14,000 customer connnections in the western Mojave Desert.

→ Components that are part of the LCID distribution system, particularly valve boxes, quickly become buried.

Located in northern Los Angeles County, LCID is a special district that serves approximately 1,400 customer connections. It was formed nearly 170 years ago to provide irrigation ditch water to orchards in Littlerock, known as the fruit basket of the Antelope Valley. Today, most LCID customers are served with potable water delivered through a network of distribution mainlines. Most of this network was constructed in the mid-1900s.

Because the LCID service area is in the western Mojave Desert, there is a constant accumulation of sand and dirt on and along unpaved roads. Distribution system components, particularly valve boxes, quickly become buried. During routine valve exercising or in an emergency, distribution system operators often must use a metal detector to locate valve covers.

Historically, it has been a time-consuming process for district operators to locate and uncover buried valves and related pipelines for repair and maintenance. District operations staff have relied on prior system knowledge and paper as-built record drawings from various mainline construction projects to locate distribution system assets.

On January 1, 2022, a bill (CA Government Code 4216) was passed in California that required all water utilities to leverage a geographic information system to record the location of newly constructed distribution system assets. LCID did not have any GIS data at the time. In response to this new bill, LCID general manager James Chaisson led the district to invest in the development of a system-wide GIS program.

The district needed a central repository for editing and reviewing information, capturing historical institutional knowledge regarding the system, and recording new asset locations and maintenance information.

LCID retained MC Engineering, Inc., an Esri partner, to develop an initial system-wide asset database and an interface for district staff to access GIS on an iPad. MC Engineering is a civil engineering firm in California that focuses on serving municipal water and wastewater systems and specializes in supporting small and midsize utilities. The MC Engineering GIS team serves as an extension of LCID water and wastewater utility staff in the development and maintenance of GIS programs. MC Engineering also provides engineering design, construction management, and grant acquisition services.

LCID worked with MC Engineering to develop a utility GIS program that would become the authoritative source of system-wide asset information. In addition, GIS-based applications were configured to provide staff access to GIS via their iPads. The company began this project by scanning all available LCID distribution system record drawings and saving the PDF images in a geographically rectified format in ArcGIS Online.

A web application was developed to enable district staff to access the record drawings. Staff can open the web map and click a polygon (rectangle) in the vicinity of interest to open the related record drawing. The app allows district staff to carry all related record drawings on their iPad and quickly access the drawings in a specific area.

In tandem with this effort, MC Engineering conducted a high-resolution (3 cm) fixed-wing aerial survey over nearly the entire 5,000-acre LCID service area. Aerial targets were strategically placed by a licensed land surveyor throughout the vicinity to allow the aerial images to be georectified.

The high-resolution aerial photos were processed with ArcGIS software to capture the location of aboveground distribution system assets at accuracies within inches of deviation. Mainline locations were estimated by comparing information shown on record drawings to geographic features shown in the aerial images. The resultant distribution system asset database was saved in ArcGIS Online, which was configured to allow district staff to access the asset locations on a mobile device in the field.

The LCID purchased an Eos Positioning Systems Arrow Gold Global Navigation Satellite System (GNSS) receiver for recording the location of assets that were not visible during the initial aerial survey. This high-accuracy receiver enables staff to locate assets within one centimeter. The LCID distribution operations team was eager to provide feedback and fill in areas of the district that were missed in the initial aerial survey.

MC Engineering staff conducted several one-day workshops with LCID staff to introduce the Eos GNSS receiver and Esri's ArcGIS Field Maps, and a final two-day workshop to correct upgrades and improvements to the system that were not documented. Discrepancies between the GIS database and old and outdated district prints were resolved based on staff knowledge.

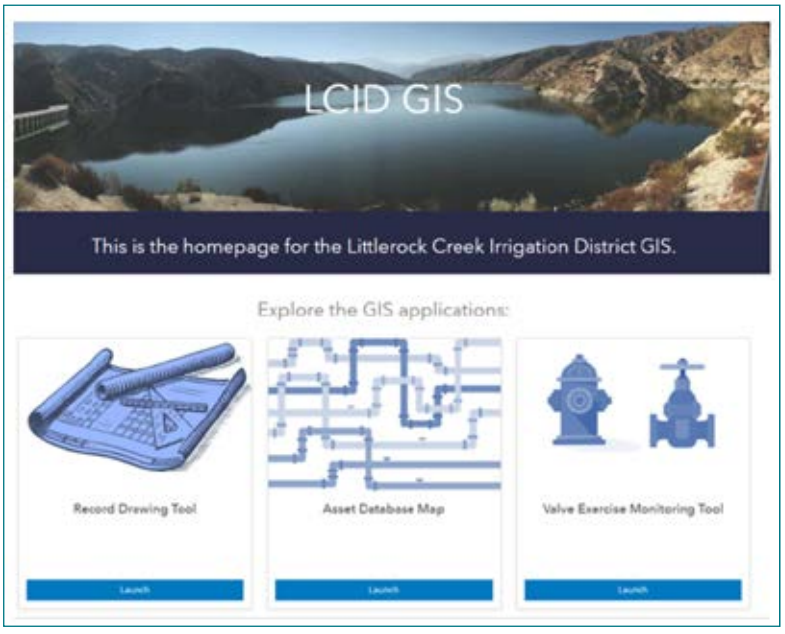
LCID staff now have access to asset locations and related information both in Esri Field Maps on a mobile device and through web applications that are accessed through a central website. Staff can view record drawings and asset locations, and add new asset locations to the GIS.

Steven Rafferty, the LCID distribution operations foreman, said that the new tools and asset database have simplified his work. He now uses the record drawing organization tool many times per week, and he often uses the asset viewing tool to

← Before the GIS was implemented, it was a time-consuming process for district operators to locate and uncover buried valves and related pipelines for repair and maintenance.

↑ The app allows district staff to carry all related record drawings on iPads and quickly access drawings for a specific area.

→ LCID staff now have access to asset locations and related information both in ArcGIS Field Maps on a mobile device and through web applications that are accessed through a central website.



get a quick look at what he is working on or looking for. The GIS program comes in handy to find valves that were mapped with the aerial survey and are now buried. The Eos GNSS receiver enables staff to find a place to dig for pipeline repairs with near perfect accuracy. This typically saves the operators time—from five minutes to several hours—when locating repair locations.

The district has completed an aerial survey as well as initial mapping of system gate valves, hydrants, hydrant valves, and mainlines. The new GIS mapping database is leveraged to record asset locations and information, monitor asset maintenance such as valve exercising, and plan for long-term asset management activities. This asset database has enabled the district to both comply with state requirements and improve operational efficiencies. Staff spend less time locating and relocating assets and more time maintaining the system.

The district plans on expanding the GIS to include water meters and blow-off points. The GIS database will be continuously used to record new construction projects. The district will also continue to refine the recorded locations of select assets that were constructed more than 100 years ago and have no plans on record.

"The experience working with MC Engineering was top-notch. MC Engineering was always there to answer any questions with professional answers. MC Engineering was helpful with gathering the information needed for the implementation of the GIS system," Chaisson said.

The GIS information gathered will inform current and future district staff members and streamline operator training. LCID team members take great pride in learning more about their system, and see this process as a journey. Even after years of working at the district, new information about the system is continuously being discovered.

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By Richard Leadbeater

Voting Is Accurate and Transparent in Saint Louis County

The Board of Elections for Saint Louis County, Missouri, uses GIS technology to monitor operations before, during, and after elections. A suite of web maps and mobile apps help streamline election processes and communicate results efficiently. Using location-based tools, the county makes voting accessible, ensures accurate districting, and provides election data to officials and constituents.

After polling centers close on Election Day in Saint Louis County, each supervising staff member for each site places an iPhone in the ballot box, secures it, and travels by police escort to the county's Board of Elections office.

The iPhone uses GIS technology to deliver real-time location data that is displayed on a map. Eric Fey, the county's Democratic director of elections, monitors the progression of each box as he waits with his colleagues to receive the night's final votes and announce election results.

Before using location data, Fey knew that the ballot boxes were on their way but couldn't pinpoint their precise location. Meanwhile, he would field phone calls from candidates, county personnel, and journalists who wanted updates on results.

Now, Fey and his team have a dashboard that takes away the uncertainty. "As ballot boxes come back, we know when we scanned them back into the office and when we broke the seal to take the results back to our tabulation room. We can zoom in on specific collection points to see which ones are accounted for and how many are outstanding. We know every part of the process and can visualize it," he said.

The iPhones that track ballot boxes work in concert with other GIS-powered tools. Together, they provide a complete operational picture throughout the election cycle. A suite of web maps and mobile apps keep officials, candidates, and constituents updated throughout. Then the cycle repeats.

Moving from Paper to Smart Maps

Fey is often asked what he does when there isn't an election. His answer is surprising: there is always an election. In the coming 18 months, Saint Louis County will host six elections, not including any special elections required by individual city charters.

The most populous county in Missouri, Saint Louis County is home to nearly one million people with more than 700,000 registered voters. What makes the region unique is its jurisdictional complexity. On top of the county's two congressional districts, there are seven county council districts, seven state senate districts, and 30 state representative districts. The county's 87 cities and villages each have their own elected officials. Voters also elect officials for 24 school districts, 25 fire districts, and a plethora of other special-purpose districts.

"We end up with this crazy spaghetti web of local governments and precincts, and it's our job to make sure people get the correct ballot," Fey said. "This is a big challenge in election administration. Everyone knows who they want to vote for, for president or governor. But in larger jurisdictions, when you get down to state representative and

county commissioner, if someone gets the wrong ballot, they might not even know it."

When Fey started working for the county in 2015, Board of Elections personnel were using colored pencils to redraw district lines on paper maps based on new census data. If these boundaries are redrawn incorrectly or aren't accurately translated into a voter database, errors occur and elections must be rerun, which is costly for municipalities and their constituents.

To solve this, the Board of Elections GIS specialists work with judges and redistricting bodies to create digital maps of voting districts. Now, the maps are available on the Redistricting Hub (links.esri.com/stlouisredistrict) on the Board of Elections' website.

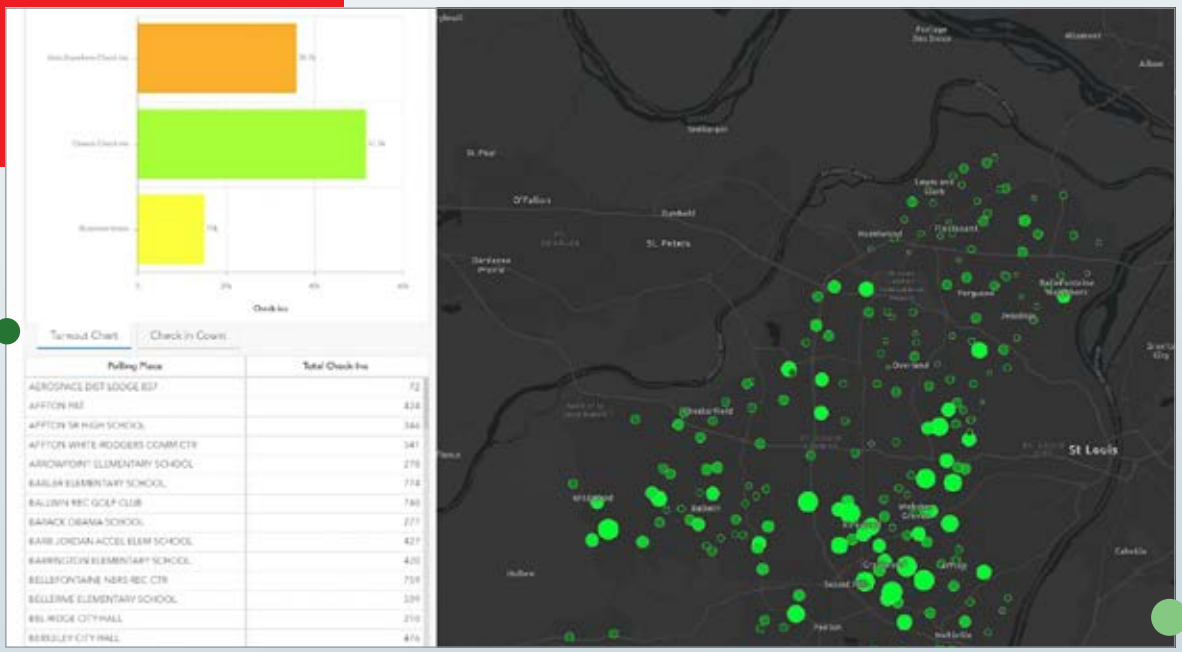
This resource aggregates all county districts, outlines their boundaries, and shows any recent changes. Most redistricting processes happen every 10 years, but if boundaries need to be redrawn, the maps must reflect changes immediately. With the Redistricting Hub, these changes can easily be made and communicated to constituents and stakeholders, including politicians whose district locations and makeup may have shifted.

Optimizing Election Preparation

Recently, new laws in Missouri made it easier for people to vote. Voters can now visit any polling center—instead of an assigned location—or vote as absentees. The Polling Place Lookup tool (links.esri.com/pollingplacelook) helps voters find their nearest polling center. For those choosing to vote as absentees, the Absentee Voting Lookup tool (links.esri.com/absentee)

↓ Election staff can further examine voter turnout on the map and in charts to track voting progress. (Screenshot courtesy of Saint Louis County Board of Elections)

↓↓ This map provides a detailed map view as well as details of various office-specific boundaries, including school districts and fire districts. (Screenshot courtesy of Saint Louis County Board of Elections)



highlights satellite sites and calculates drive times to locations where voters can drop off their ballots. Voters can also use the Saint Louis County Sample Ballot Lookup tool (links.esri.com/sampleballot) to explore the candidates and initiatives specific to where they live.

Location technology helps the Board of Elections prepare for these changes. Fey's team used information from previous elections to determine where to place new sites for early voting.

"Data from the November 2022 election showed us where people were voting. We could also see that there were some dead zones where we didn't have a polling center. Because there wasn't one, those people just didn't vote early; they waited until Election Day—that was a big learning moment for us," he said.

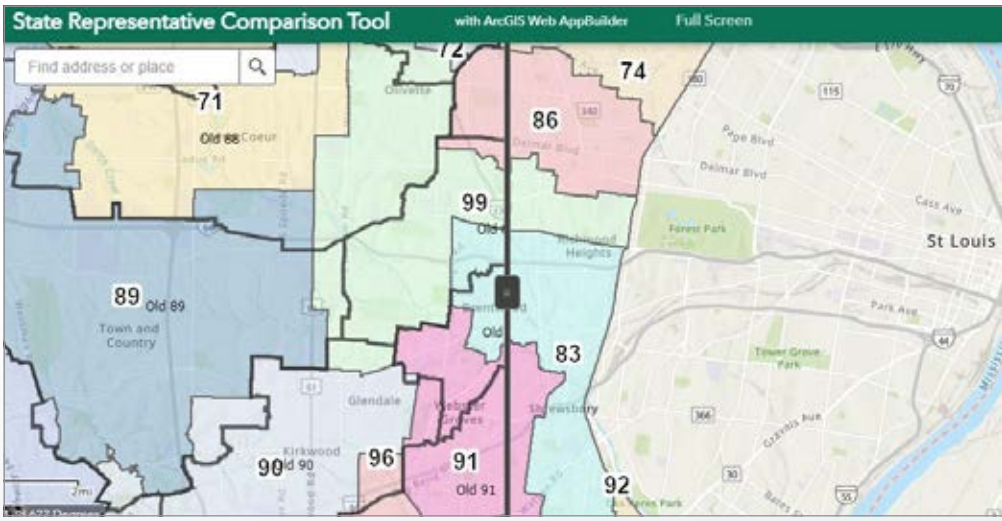
The Board of Elections is also responsible for distributing voting equipment to nearly 300 polling centers across the county. Prior to implementing GIS technology, warehouse employees would sit down with paper maps and draw out delivery routes. Now, workers optimize delivery routes by considering traffic conditions and the shortest distance to minimize travel time.

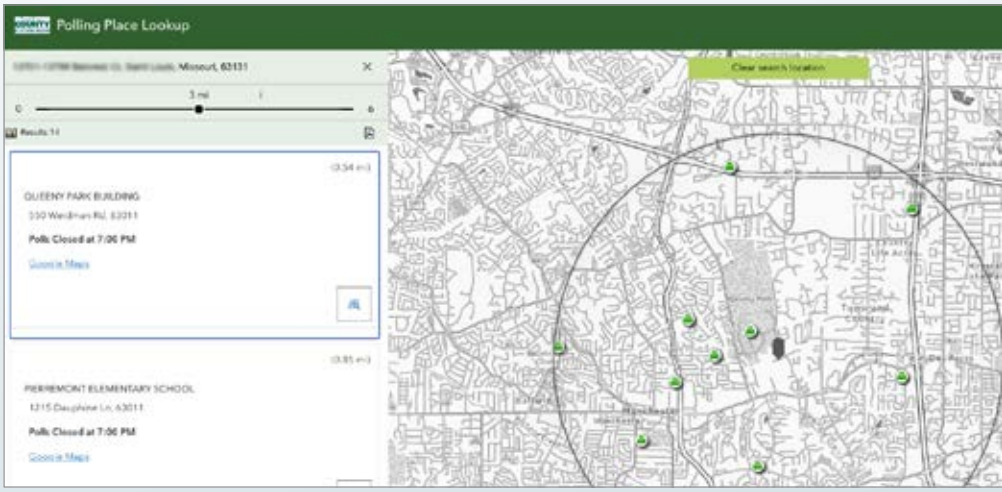
The absentee ballots team coordinates voting for residents of nursing and retirement homes, which includes delivering ballots to nearly 100 facilities. "The team [had previously] relied on employees with years of knowledge about the process and it was always confusing," Fey said. "A few years ago, they went to the GIS analysts and asked for help—that's when I realized our thinking had really changed. Now we have a dashboard to track and manage the nursing home visits we make. It's made the job so much easier."

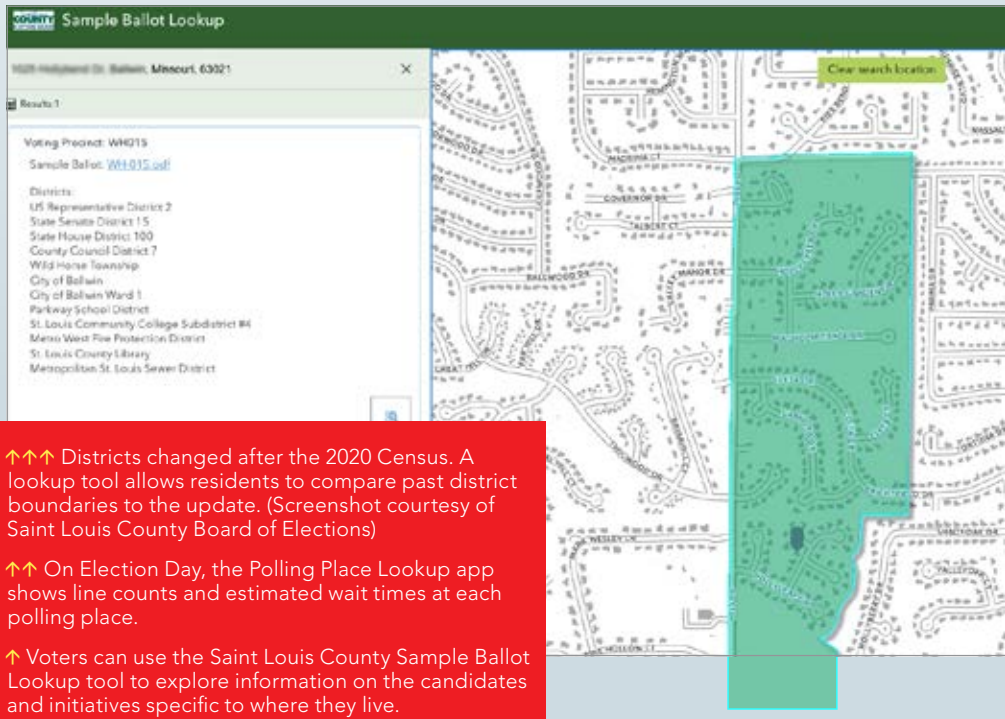
Setting Expectations

On Election Day, GIS apps keep county officials and constituents informed in real time. Throughout the day, voters can use the Polling Place Lookup tool to monitor wait times at each location. A volunteer counts the voters in line and logs the number in ArcGIS Survey123, which then populates on the web map.

"On Election Day in 2020, we had 365,000 hits to the line tracker app on our website. That's about as many people who voted on Election Day in Saint Louis County, so it was very popular," Fey said.







↑↑↑ Districts changed after the 2020 Census. A lookup tool allows residents to compare past district boundaries to the update. (Screenshot courtesy of Saint Louis County Board of Elections)

↑↑ On Election Day, the Polling Place Lookup app shows line counts and estimated wait times at each polling place.

↑ Voters can use the Saint Louis County Sample Ballot Lookup tool to explore information on the candidates and initiatives specific to where they live.

The poll books that voters use to sign in are connected to Fey's office and automatically populate a map that shows where and when people are voting. Fey and his team monitor polling place wait times to anticipate problems. If a device malfunctions or another error occurs, Fey can locate the mobile team member closest to the issue and dispatch them to troubleshoot.

"Situations can develop rapidly on Election Day and GIS gives us the ability to visualize what is happening," said Rick Stream, Republican director of elections and Fey's counterpart. "With these tools in place, election days seem somewhat less fraught than they used to be when we could only guess at what was happening in the field."

Looking Forward: Anticipating and Innovating

As election results come in, they're displayed on maps on the Board of Elections' website. Using data, maps, and mobile tools throughout the election cycle grants a high level of transparency and authenticity to the county's processes. When Fey needs to answer a question, he has authoritative data to point to.

This information matters when addressing allegations of foreign disinformation campaigns, voter fraud, or voting machine security. "New folks are coming into election administration with IT competencies. They want to emphasize outward-facing transparency and make processes more accessible to the public—GIS is a great tool for that," Fey said.

After each election, staff members aggregate and analyze all the collected data and Fey looks for potential process improvements. If he notices more mobile workers were dispatched to certain areas, he takes note. If a certain polling place is popular, he can allocate additional resources to that location for the next election.

Fey's office compiles a biennial report filled with maps after every general election. Every elected official receives a physical copy. The reports help officials visualize the regions where they did or didn't receive support. The maps speak to the large amount of data the Board of Elections collects and synthesizes.

In the future, Fey and his team want to take historic election data and display it on interactive maps for constituents, researchers, and journalists to explore. He's also hoping to enhance real-time data collection on Election Day to include interactive maps with live results, down to the precinct level.

They are ahead of the curve. According to the National States Geographic Information Council, the majority of states are in the early stages of integrating GIS into their election processes. Fey noted that, by focusing on hiring GIS personnel and investing in the tools they need, the Board of Elections created a culture where people use location data to solve problems and innovate. "It's these little improvements," Fey said. "Every little piece builds on something else."

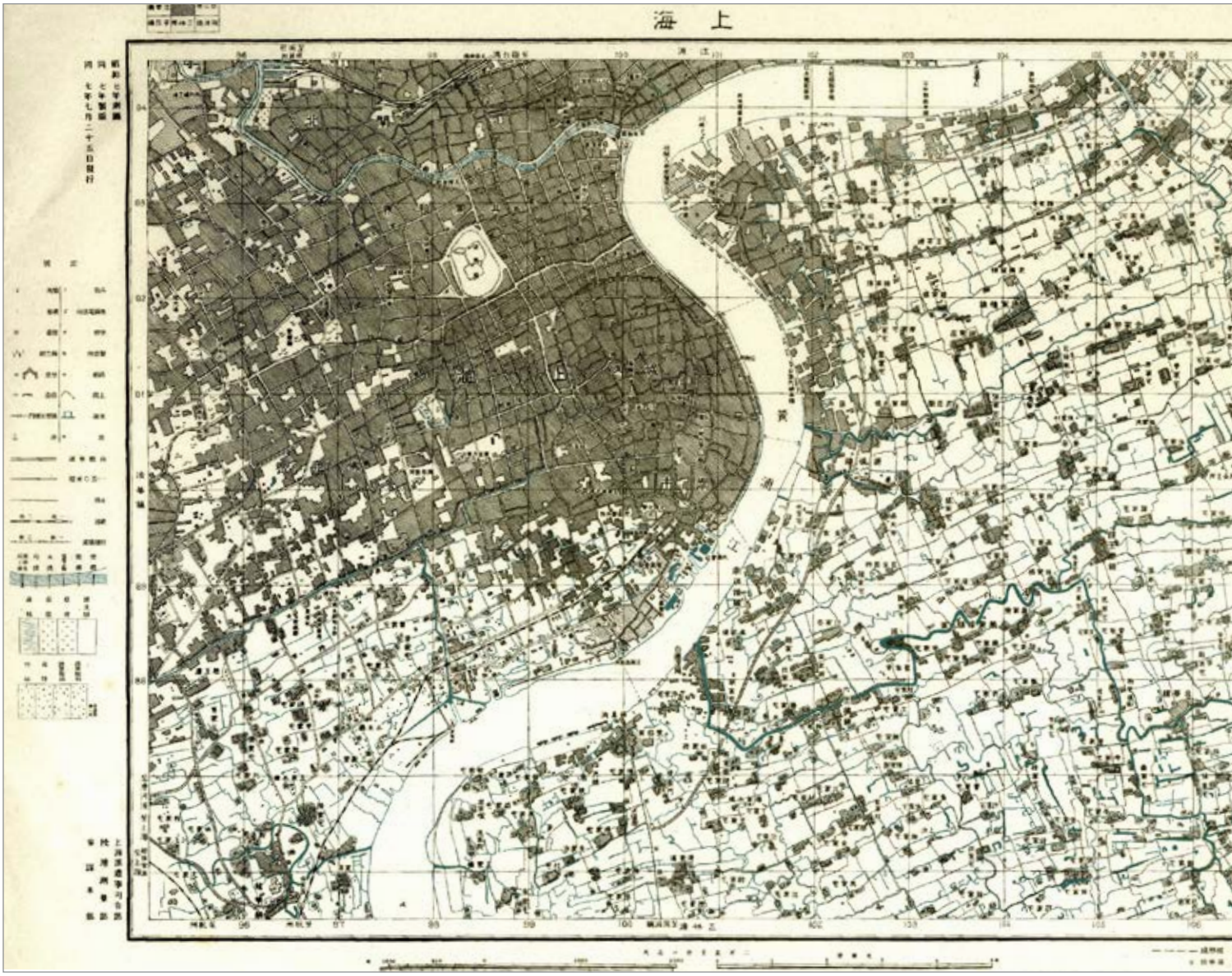
Learn more about how GIS is used to modernize elections planning at links.esri.com/GIS4elections.

About the Author

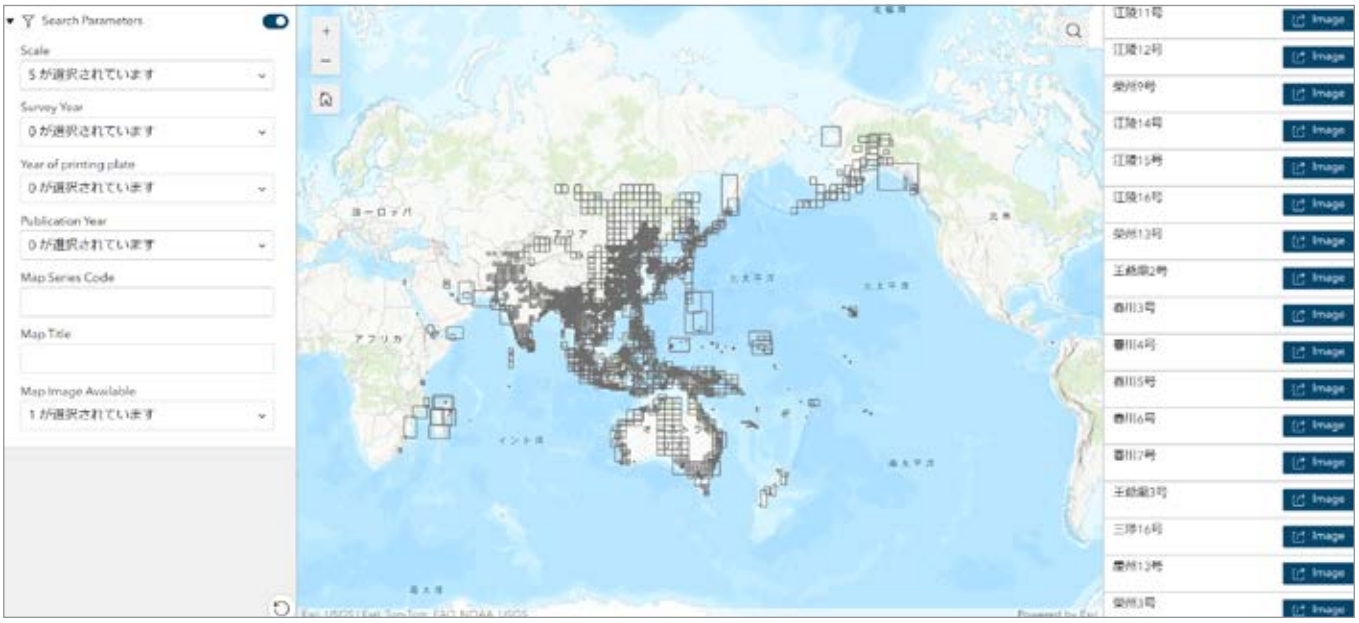
Richard Leadbeater is Esri's state/provincial government industry solutions manager. Leadbeater focuses on developing tools and solutions that address the administrative functions of policy, elections, redistricting, and government business processes. He is passionate about helping governments gain the greatest value from the data they generate. Prior to joining Esri in 1997, he worked at the Washington Suburban Sanitary Commission, the seventh-largest public water and wastewater utility in the United States, where he developed and implemented GIS and computer-aided drafting and design and documented imaging technologies.

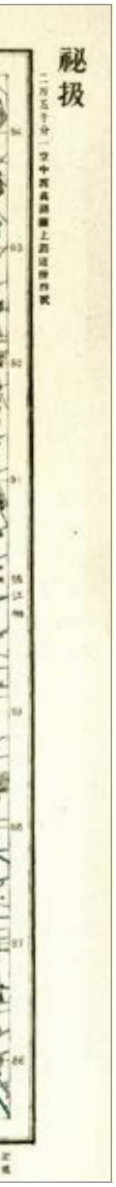
More than 10,000 Maps Reveal the Asia-Pacific Past in Greater Detail

By Yukihisa Hoshida, Ryohei Sekine, Yuzuru Isoda, Shohei Nagata, and Tomoki Nakaya



Maps have a profound association with warfare. Historically, numerous cartographic agencies were integrated with their countries' military organizations. The same was true for the Japanese agency that produced many maps outside Japan's borders for military operations and colonial administration before the end of World War II. These maps were referred to as *Gaihozu*, meaning "maps of outer lands."





↑↑ A Gaihozu map from 1932 shows the Shanghai urban area and its surroundings, extending to the mouth of the Yangtze River.

↑ A current 3D topographic basemap shows the same portion of Shanghai as the 1932 map (above).

← This map shows the vast area of the Asia-Pacific region covered by the Gaihozu collection at Tohoku University. The web application lets users conduct visual searches of Gaihozu maps within the archives.

Apart from their original purpose, these Gaihozu maps now stand as invaluable scientific records showing the previous condition of land in various parts of the Asia-Pacific region. Currently, advancements in satellite observation technology permit the capture of detailed landscape changes over a wide area. However, understanding historical land use and vegetation in the Asia-Pacific region prior to the advent of satellite technology remains challenging.

What did Shanghai look like a century ago? Currently, Shanghai has a population of 20 million, which makes it one of the largest cities in the world. The area that is today the city of Shanghai was formerly known as the Shanghai International Settlement, as indicated by the Gaihozu maps.

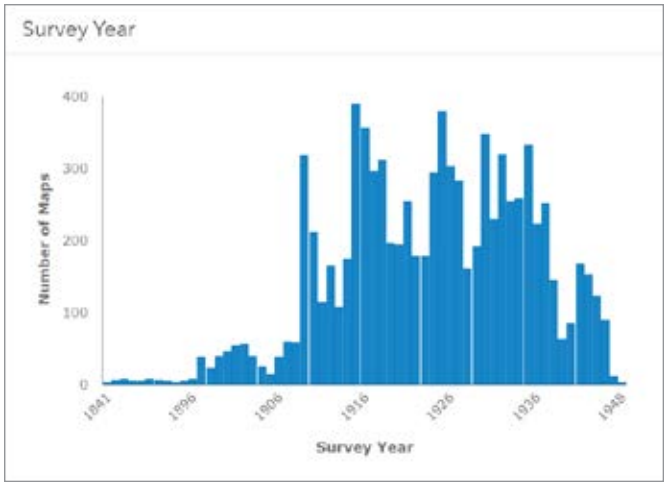
With the construction of many skyscrapers, the urban area of Shanghai has undergone significant change since the 1930s. A Gaihozu map from 1932 shows of the urban area of Shanghai and its surroundings extending to the mouth of the Yangtze River in Shanghai in 1932. A current 3D topographic basemap of the same area of Shanghai shows that rural villages have disappeared and the road layout has substantially changed.

The geographical coverage of the entire Gaihozu collection at Tohoku University encompasses a vast area that extends north to Alaska, east to the United States mainland and the Isthmus of Panama, south to Australia, and west to Pakistan and Afghanistan as well as the eastern parts of the African continent.

These maps were surveyed between 1886 and 1945. The Gaihozu collection, which is currently housed at Tohoku University, comprises more than 10,000 maps, making it one of the largest

collections of 19- and 20-century Japanese maps and a highly valuable resource for the study of landscapes in the Asia-Pacific region during that era.

At the conclusion of World War II, when the Japanese military was disarmed, the Gaihozu maps were scheduled for incineration. However, Japanese geographers, recognizing the scientific value of the maps, intervened and successfully rescued them. Approximately 100,000 Gaihozu maps, including numerous duplicates, were packed into a single freight car and transported to Tohoku University in Sendai City, a major northeastern regional city in Japan, amidst the chaos at the end of the war.



→ This histogram of Gaihozu maps stored at Tohoku University is organized by survey year.

In the late 1990s, geographers at Tohoku University began cataloging the Gaihozu collection. The catalog was used as a map metadata source in the creation of digital archives of maps. In the 2000s, the digital maps were created by scanning the paper maps.

Tohoku University has made the Gaihozu Digital Archives available to the public since the 2000s to increase awareness of their existence and contribute to research and education. The archives were designed as a web-based system for the display of Gaihozu map images and has been utilized by numerous researchers.

[An article about this web app, "Finding Lost Landscapes in Southeast Asia," appeared in the Fall 2020 issue of ArcUser *(links.esri.com/prevapp).]*

However, in 2022, this public access system became unavailable due to aging servers and issues with system management. In October 2023, the project team responsible for renewing the Gaihozu digital archives launched a new initiative to make these maps publicly accessible using cloud technology, which would minimize hardware maintenance costs.

Ultimately, the renewed Gaihozu Digital Archives were released in January 2024 using ArcGIS Online. The archives currently contain more than 10,000 images stored at Tohoku University, with both English (gaihozu-tohokugeo.hub.arcgis.com/) and Japanese (gaihozu-jp-tohokugeo.hub.arcgis.com/) sites now available.

The digital archives include web applications for searching and viewing Gaihozu images, brief narratives for selected maps, and comprehensive background explanations of the Gaihozu collection. ArcGIS Hub enables the incorporation of diverse digital content, such as web applications, images, texts, and graphs. Multiple individuals can collaborate and edit the sites. ArcGIS Hub was instrumental in the sites' efficient development. The websites function optimally on both desktop and mobile devices.

Two web applications let users search for Gaihozu images. One application provides a mapcentric experience based on map location and extent. Given the extensive geographical coverage of these maps, search capability using the index map is crucial.

The other application enables users to search by map metadata items, including region name, scale, print year, and map title. Users can view the Gaihozu map image and its metadata by clicking the button on the web application.

The project team used ArcGIS Experience Builder, which expedited building applications to provide both search methods. A comma-separated value (CSV) file containing the entire database can be readily exported from the web application for subsequent analyses.

Gaihozu maps left behind after World War II have been scattered around the world, which resulted in an incomplete historical record. Many Gaihozu maps were confiscated by the Allied Forces and are now stored at various institutions in the United States. Many maps have been left in storerooms for extended periods. Recently, Stanford University Libraries and other institutions made their collections available to the public after cataloging them.

The establishment of a similar web-based system for Gaihozu, including the Gaihozu Digital Archives, and sharing the basic database structure of map images and metadata may facilitate collaboration between dispersed archives through web services. These efforts can contribute to a more comprehensive understanding of Gaihozu maps and—through them—the past vegetation and land use in the Asia-Pacific region during the late 19th and early 20th centuries in greater detail than was previously possible.

Dr. Shigeru Kobayashi, a professor emeritus at Osaka University and an authority on Gaihozu studies, posits that the Gaihozu collection at Tohoku University is among "the most significant materials for the research and education of modern environmental change in East Asia and the western Pacific."

The map images in this collection provide a detailed account of the historical landscape of the region and reveal changes that have occurred over time. GIS allows for systematic spatiotemporally positioning them and the mapping and analysis of changes detected.

For more information on this collection, contact the project team of Gaihozu Digital Archives at gaihozu-digital-archives@googlegroups.com.

About the Authors

Yukihisa Hoshida is the vice president of OpenConcierge, a nonprofit organization in Japan. He is passionate about geography and GIS and has been working with GIS for more than 15 years. He holds a master's degree in geography from Kyoto University, Japan.

↑ The Top Page of the Gaihozu Digital Archives

← The web application offers a straightforward list-based interface for searching the Gaihozu map database so that users can retrieve map metadata, such as the map scale and year printed, and thumbnail map images with links to the detailed map images.

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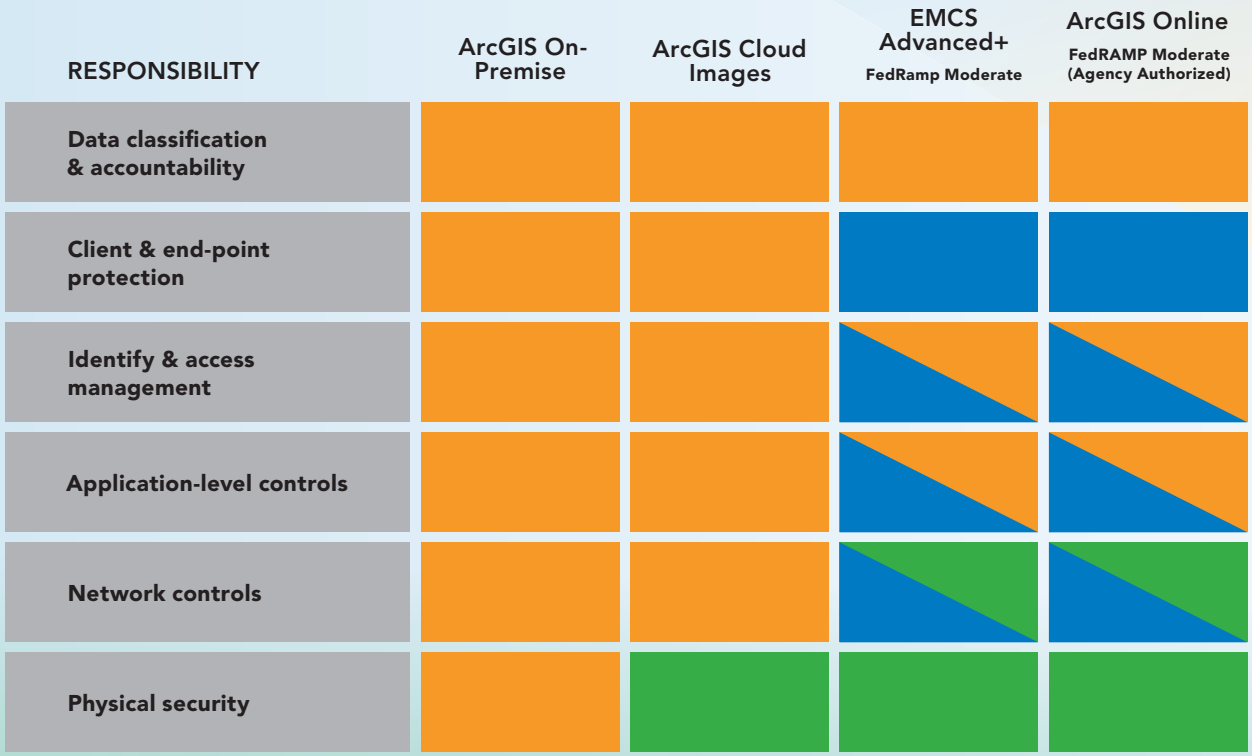
DON'T LET YOUR OPERATIONS BE DISRUPTED



↑ This chart shows the shared responsibility model.

The phrase "keep the home fires burning" is an idiom that means "to maintain daily routines and provide the necessities of life in a home or community."

But what does that phrase have to do with your ArcGIS Online and ArcGIS Enterprise operations?

To be usable, both need users and content. Someone must manage those users and be able to manage content and settings. That is the person who fills the administrator role.

In any organization, there will be churn. People will separate from the organization. They take vacation or annual leave. They may be out sick or dealing with a family situation for an extended period. There are endless reasons for a resource to be unavailable. Churn doesn't necessarily have to mean disruption. With planning, service disruption caused by organizational changes may be avoided.

ArcGIS Online, as software as a service (SaaS), follows a shared responsibility model. Some aspects of ArcGIS Online are provided and managed by Esri, and other aspects of ArcGIS Online are owned and managed by your organization. For instance, Esri provides the code and manages the team that keeps ArcGIS Online running. Your organization provides content; designs the look and feel of its ArcGIS Online organization; assigns software licenses; and manages members, including members who fill administrator roles.

In ArcGIS Enterprise implementations, your organization assumes most of the responsibility. In many modern environments, responsibilities related to the physical hosting environment are managed by a hosting provider (e.g., infrastructure as a service [IaaS]), but all other aspects of the deployment are managed by your organization.

Part of keeping both ArcGIS Online and ArcGIS Enterprise running involves creating, updating, and following contingency plans. In an emergency, how does an organization pivot? If a key resource is unavailable, who steps up to fill the gap?

Similarly, whether your organization utilizes ArcGIS Online, ArcGIS Enterprise, or both, it needs to be prepared to respond to contingencies. If your administrator becomes unavailable for whatever reason, who has been assigned the ability to assume that role?

Ultimately, your organization bears the responsibility of managing ArcGIS Enterprise or ArcGIS Online organization deployments. Esri respects the privacy and sensitivity level of users and content that ArcGIS Online organizations manage. Esri does not access or manage customer content or invite members to an ArcGIS Online organization without very strong justification. The process Esri has defined and documented is onerous and time-consuming. It must be. When Esri must administer a customer's ArcGIS Online organization, considerable avoidable risk is introduced. This is a great responsibility that Esri does not take lightly.

Esri has no access to your ArcGIS Enterprise implementation. In this case, business continuity and incident response planning are your organization's responsibility. It is crucial to the success of your organization's ArcGIS Enterprise deployment. Not only should GIS administrator contingencies be considered, but availability challenges must be holistically anticipated across the entirety of the system.

Build a plan early, review it, and update it frequently. At a minimum, it should be updated after an impactful organization change. If the administrator is taking planned leave, you should promote a user to the administrator role. Better yet, name multiple administrators. Two or three administrators are usually enough. ArcGIS Online and ArcGIS Enterprise support custom roles that can provide fine-grained permissions if the scope of the administrator role is too broad for a short, planned leave. Design custom roles that fit your organization's needs.

For many organizations, a convenient way to avoid substantial service disruptions is to use a single sign-on technology such as Security Assertion Markup Language (SAML), which allows centralized user administration at the organization's domain level. If an administrator becomes unavailable, their account may be accessed by simply requesting the domain user's password be changed by the domain administrator. The administrator account may then be accessed and used to assign someone else to the administrator role. For organizations that do not have SAML or have not configured it for use for ArcGIS Online, domain administrators can intercept password reset emails and forward them to the user who has been delegated to perform the administrator's responsibilities. These options are preferable to asking Esri to perform administrative tasks on your organization's behalf.

For ArcGIS Enterprise customers, ensure that hosts can be accessed via console in case an ArcGIS account change is required. Identify those users who can log directly onto those servers, those who have the necessary rights to run ArcGIS account recovery tools, and those who can quickly and effectively troubleshoot other outages. Leverage resources like Esri's *ArcGIS Enterprise Hardening Guide* (links.esri.com/hardening), which offers not just advice for configuring security options and system settings, but also information on critical strategic maturity tasks such as building out contingency plans.

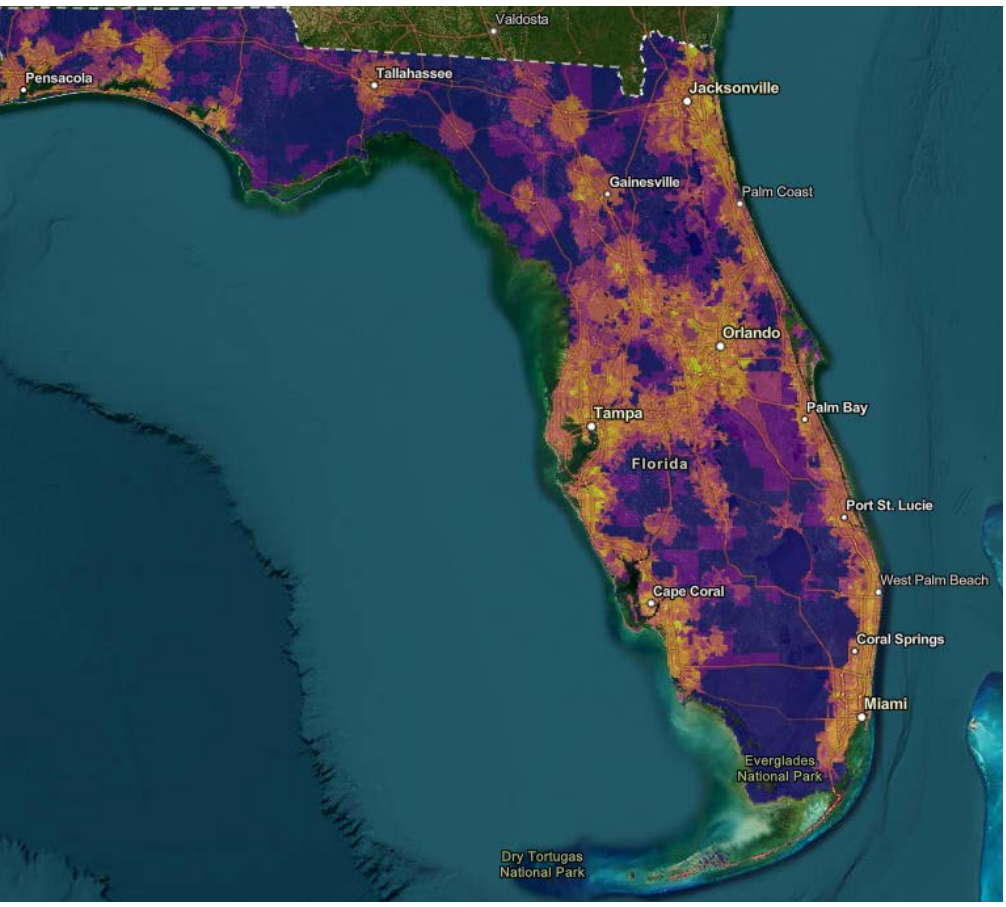
Part of keeping both ArcGIS Online and ArcGIS Enterprise running involves creating, updating, and following contingency plans.

Do not wait until the administrator is unavailable to think about this critical aspect of managing your ArcGIS Online or ArcGIS Enterprise organization. When all else fails, you can contact Esri Support Services for guidance and options.

Building a Best-in-Class Culture with Esri Technical Certification

By Suzanne Boden

The GIS leaders at England-Thims & Miller, Inc. (ETM), have developed a program for building and maintaining technical expertise to support the expanding role of GIS at ETM.



← This map, created by ETM for a client in Florida, shows the results of a statewide suitability analysis.

ETM, an Esri partner, is an engineering and construction firm specializing in land development and infrastructure design for both the public and private sectors. Based in Jacksonville, Florida, the firm's clients include commercial organizations, utilities, and municipalities.

In the late 1990s, ETM adopted GIS to support its engineering, planning, construction, and asset management solutions. Only two staff members at that time had experience with GIS, which was then used to create maps for the firm's engineering team and the City of Jacksonville, a long-time client.

Since then, ETM's GIS team has grown substantially and now provides services and solutions to clients throughout the United States. Through its Geospatial Technologies (GST) department, ETM offers DeepVUE Geospatial software, a cloud-based GIS portal environment powered by ArcGIS. GST team members also provide a suite of consulting services, including GIS strategy and planning, application development, implementation, and data conversion and migration.

ETM provides its clients with a range of geospatial consulting services, including site suitability analysis.

Olivia DeSimone, GISP, joined ETM in 2023 as a geospatial program manager and

leads the DeepVUE Geospatial team.

"We're one of the more unique departments here at ETM," shared DeSimone. Although the department was initially created to support the company's internal GIS needs, ETM's executive leadership team decided that GIS was a separate viable business unit because ETM develops DeepVUE portals and helps clients use spatial analysis to answer their questions and solve problems.

"We still support ETM's internal business needs. For example, if one of our planners needs a zoning map for an exhibit they're submitting to a local government, we provide that. But now we also have a broader set of land development clients using our geospatial services. Those clients might not work with ETM in any other capacity at all."

A Vision to Be the Best

ETM holds the ArcGIS System Ready specialty designation, which recognizes a partner's ability to deliver content, services, or solutions using the latest ArcGIS technology. Partners with this designation must demonstrate a strong commitment to training their staff on the latest ArcGIS software versions.

Remaining tightly aligned with Esri's technology strategy is a priority for DeSimone and Daniel Kiesling, director of geospatial operations. Kiesling, who also joined ETM in 2023, has an ambitious vision for GIS.

"As an organization, we want to be the best in GIS consulting. That means being at the forefront of Esri technology. It means being in lockstep with concepts, new tools, and how Esri talks about the changing GIS landscape," he stated.

ETM's workforce is a strategic asset in its quest to be the best. To ensure that the skills of GIS team members keep pace as technology evolves, Kiesling and DeSimone have prioritized workforce development. Esri technical certifications, which validate knowledge and skills in applying ArcGIS software, play a pivotal role in their strategy.

In 2023, they launched an initiative requiring all GIS staff to achieve a certification. This ambitious endeavor prompted staff across the board—from college interns to seasoned managers with decades of experience—to rise to the challenge and demonstrate their expertise through certifications.

"Olivia quickly realized that a lot of value could be added to our organization by having our staff achieve Esri certifications," said Kiesling. "We wanted to make sure they were talking in unison about cutting-edge technology concepts. Creating a strong knowledge foundation for our staff was important to us."

Creating Clear Paths for Career Progression

DeSimone is an advocate for certification, having experienced its benefits herself. She earned her first Esri technical certification (ArcGIS Desktop Professional) while preparing for the GIS Certification Institute's GIS Professional (GISP) certification. Achieving the Esri certification demonstrated her GIS technical skills, which is a requirement of the GISP program.

"At my previous job, when I became a manager, I recognized the importance of encouraging staff to pursue a certification, both for their own professional development as well as to help them gain skills that would help the organization grow as a whole," said DeSimone.

"When I came to ETM, I saw a lot of potential to align the positions and roles to certifications, not just to foster professional development, but to help create a path. We have a lot of people who are eager to progress in their career, but they didn't know what skills they needed.

"Esri technical certifications became a great way for our people to demonstrate their aptitude and readiness to step into the next logical role in their career progression. By tying career paths to the Esri certifications, we could say, 'Oh, you want to be an analyst? That's fantastic! Typically, an analyst has skills that are at the ArcGIS Pro Associate level.'"

A Robust Plan for Exam Preparation

Kiesling and DeSimone realized that achieving a technical certification might seem daunting to some team members and were committed to actively supporting everyone through the process. They crafted a plan to do just that.

They met with each team member to select a certification exam that aligned with their role and skill set. They prioritized exam preparation and worked with Esri training consultant Marc Weniger to identify training resources for each certification.

"ETM adopted a very proactive stance toward technical certification," said Weniger. "Recognizing the importance of certifications to their business strategy, they strategically incorporated them into their business model and crafted a plan tailored to each individual's needs." After discussing the plan with Weniger, DeSimone and Kiesling matched training modalities to certification exam levels.

Team members preparing for a professional-level exam could attend instructor-led training, while those preparing for a foundation- or associate-level exam used Esri Academy learning plans that include a set of e-Learning resources tailored to each exam.

To demonstrate how important certification was to their organization, Kiesling and DeSimone decided that exam preparation time should be integrated into the workday.

"We told them, 'Here's what a perfect week looks like,'" said Kiesling. "We gave them x number of hours in client work; x number of hours for meetings and organizational work; and four to five hours per

week in allocated, paid time to study. We wanted to give them time during the work hours to study and work on this together."

Creating an environment where everyone was working toward a shared goal was a key contributor to the plan's success.

"We did check-in meetings for people who were preparing for each exam," Kiesling explained. "We had a cadence for people to sit down and ask each other questions like, 'What are you struggling with in the learning plan?' We wanted to foster collaboration among the team so that they knew who else was working toward the same certification that they were, and they knew who they could bounce questions off of."

As more staff members began preparing for their exam, the spirit of collaboration blossomed and Kiesling and DeSimone noticed a gamification aspect taking hold.

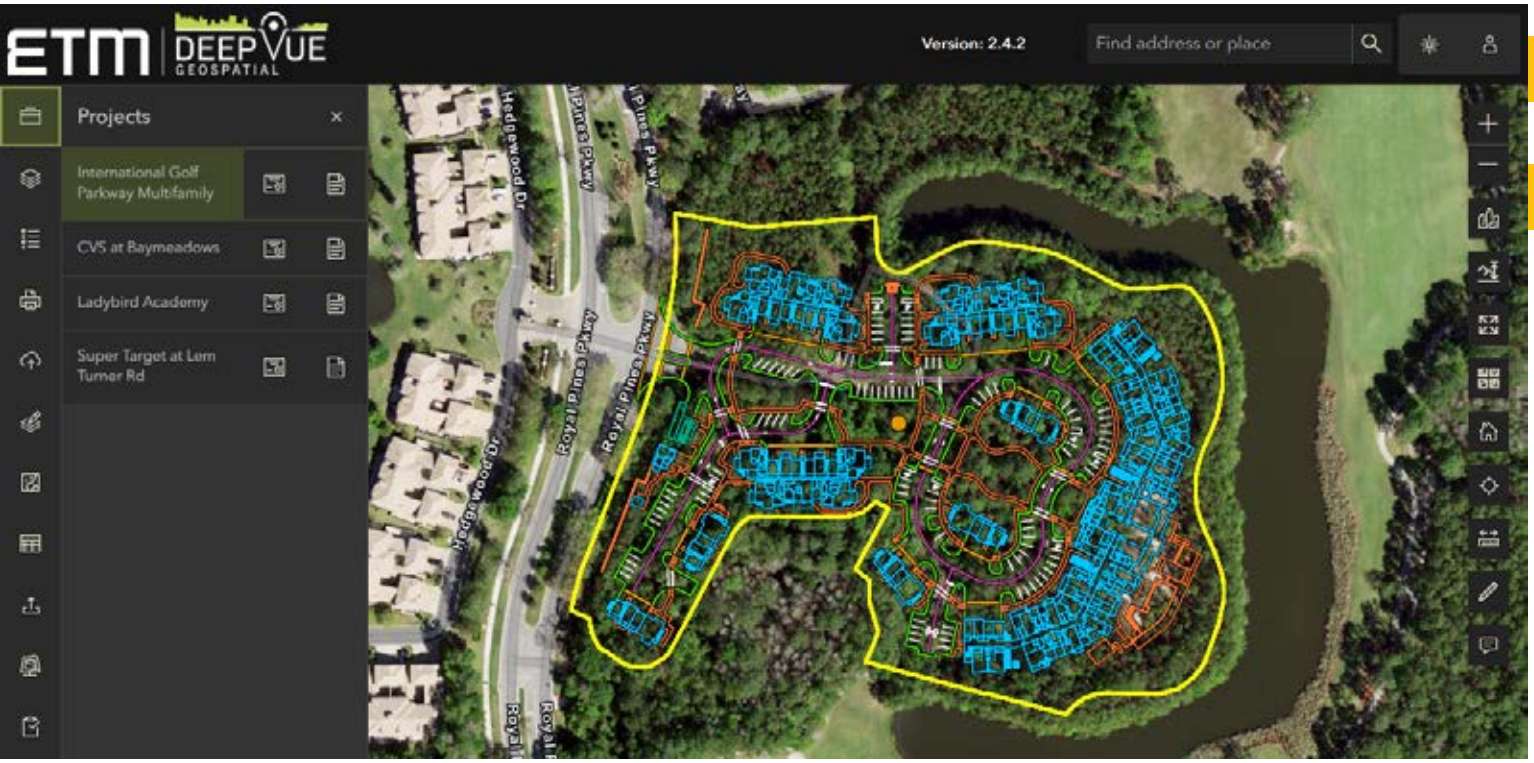
"The team found satisfaction in completing the learning plans. They liked having a set of classes to go through," said DeSimone. "We had one team member who took the GIS Fundamentals Foundation exam and then said, 'I'm going after the ArcGIS Pro Foundation exam in two weeks'—and he did it! He's also voiced interest in the ArcGIS Developer Foundation exam. He hadn't really been working in that skill set, but he's demonstrated an aptitude for that type of work and so now that exam is helping us specialize the types of work he's doing for our team."

Encouraged by DeSimone and Kiesling, foundation-level exams were taken by many of the staff members.

"We really wanted people to start with an exam that was attainable for them, because we do see this as a long-term initiative," DeSimone said. "We want people to continue to pursue certifications. By building their confidence and gaining their buy-in with the first exam, next year they can go after the next level."

Assessing the Impact of Certification

As in many organizations, GIS experience varies among GST team members. While some are seasoned GIS professionals, others had no formal education or prior workplace experience with GIS before joining ETM. Preparing for the GIS Fundamentals Foundation and ArcGIS Pro Foundation exams was instrumental to those employees gaining a more holistic understanding of GIS, according to DeSimone.



↑ DeepVUE Geospatial, a cloud-based GIS portal environment powered by ArcGIS, enables land development firms to centralize their land acquisition process and projects by accessing data, project documents, permits, analytics, and assets in a single portal.

"One common thing that we've heard from those staff members is that preparing for and taking those exams really fleshed out their skill set and honed their knowledge of the Esri ecosystem. It's helped them gain a better understanding of terminology and of things they didn't know that they didn't know," she said.

Another common theme that DeSimone heard was that working toward a common goal together made the group feel more like a team. Because they are located in different offices and work on different projects, opportunities for team collaboration had been limited before the certification initiative.

Collectively, the GST team achieved 10 certifications in 2023. Kiesling and DeSimone are proud of their team's accomplishments and are continuing the certification initiative this year.

Reflecting on their ambitions for the year, DeSimone stated, "Our goal is for every member of our staff to obtain an Esri certification that aligns with their experience by the end of 2024. Our team is more motivated than ever, and with the momentum from last year, I believe we're well-positioned to exceed our aspirations and further advance our collective expertise."

Building a Culture of Growth and Leadership

In alignment with other ETM departments, Kiesling's vision for GST includes a strong desire to be not just the best in GIS consulting, but also the best place to grow a career.

"We want to create a best-in-class culture that people want to be a part of. One of the concepts that we stress in building our business is, 'train your people to leave but treat them to stay.'"

By providing their staff with paid time to prepare for exams, paid-for exam vouchers, and a tangible reward for certification achievement, ETM's approach to the certification initiative exemplifies that concept.

"If your employer is showing you a career path with certification and is willing to pay for it—and, once you pass that certification, is incentivizing you with a bonus check—that creates an incredible opportunity for professional growth," said Kiesling.

DeSimone added, "I knew about the certification badges and all the great resources that Esri provides to help individuals showcase their skills after passing a certification exam. I knew that would reflect well on the individuals and give them a sense of accomplishment, but it also helps us establish ETM as a leader in the geospatial industry."

Kiesling's quest to be the best-in-class GIS service provider is right on track.

About the Author

Suzanne Boden is the training marketing manager at Esri, where she champions the value of lifelong learning and the people and organizations that apply GIS to accomplish big goals. When not working, she's practicing sustainable gardening in Southern California.

Accessibility Built into Your Web Maps with ArcGIS Maps SDK for JavaScript

By Kitty Hurley and Kelly Hutchins

Interactive maps are very visual in nature. Apps can reach wider audiences when additional context—such as the map's purpose or the data included in the map—is provided for audiences with low or no vision. The same strategies can also support lower internet speed connections that take longer to load content in an app.

While a fully sighted user can determine when a map has loaded on a page, users who rely on screen readers or other assistive technologies may not know when a map has loaded in the app. When content dynamically changes, its context can be provided to a user through assistive technologies with an Accessible Rich Internet Applications (ARIA) live region. *[ARIA live regions provide a way to programmatically expose dynamic content changes, such as an update to a list of search results on the fly or a discreet alert that does not require user interaction, so that they can be announced by assistive technologies.]*

Add a Live Region

To provide similar on-demand context when the map has loaded to assistive technologies, a live region can be added to the map. Add an aria-describedby attribute to the parent element of the map, such as the document's body. The aria-describedby attribute will be associated with another element's id on the page, where the description will be provided. The element can also include the aria-live attribute set to polite so users receive the information when they are idle. (See Listing 1.) By adding an aria-describedby attribute, those navigating an app with assistive technologies will have the ability to better understand the content in the app.

To visually hide the description from users, add a sr-only class to the element. The class will still contain the description's text contents, but will be visually hidden in the app via CSS, as shown in Listing 2.

To use a similar strategy for low internet speeds, the CSS class as shown in Listing 2 could be omitted to provide both visual and descriptive information to users. This deals with messaging that cannot be read or that will be translated by assistive technologies.

Dynamically Add the Description

Update the live region with information from the web map after the view is ready with the web map's title and add it to the live region as shown in Listing 3.

Create a Map Description

The map can also contain a description when a user is actively focused on the map with assistive technologies. Like a live region, a new element can be added to contain the map's description. As shown in Listing 4, add the same sr-only class to the element, where the description will be visually hidden to users.

If an app contains a web map, the web map's snippet or description can be used to update the map-description element, which provides additional context on the map's purpose and contents to the user.

To add the description to the map view's surface node, use getElementsByClassName to return elements from the esri-view-surface class. There is only one element, but the method returns an array of results. The spread (...) syntax iterates through the array, which applies the description to the element as shown in Listing 5.

```
<body aria-describedby="map-loaded">
  <p id="map-loaded" aria-live="polite" class="sr-
only"></p>
</body>
```

Listing 1

Listing 2

```
.sr-only {
  position: absolute;
  width: 1px;
  height: 1px;
  padding: 0;
  margin: -1px;
  overflow: hidden;
  clip: rect(0, 0, 0, 0);
  border: 0;
}
```

Explore the Demonstration App

Access a demonstration app with the code (links.esri.com/democode) and app (links.esri.com/demoapp), available on GitHub.

To test the app:

1. Enable a screen reader, such as the free NVDA screen reader (https://www.nvaccess.org/) or JAWS (links.esri.com/jaws), both for Windows; or VoiceOver, which is included with MacOS.
2. Open the app in a browser window. For VoiceOver, Safari is the MacOS-supported browser.
3. Navigate into the app and explore the live region and map description.

Listing 3

```
const mapLoadMsg = document.getElementById("map-loaded");

await view.when();
mapLoadMsg.innerText = `${map.portalItem.title} map has loaded.`;
```

Listing 4

```
<p id="map-description" class="sr-only"></p>
```

Note: Not all assistive technologies support the aria-describedby attribute. For example, Narrator does not. For full supporting information of aria-describedby, visit a11ysupport.io.

Listing 5

```
const mapLoadMsg = document.getElementById("map-loaded");
const mapDescription = document.getElementById("map-description");

await view.when();
mapLoadMsg.innerText = `${map.portalItem.title} map has loaded.`;
mapDescription.innerText = map.portalItem.snippet;
const surfaceEls = [...document.getElementsByClassName("esri-view-surface")];
surfaceEls.forEach((surfaceEl) =>
  surfaceEl.setAttribute("aria-describedby", "map-description")
);
```

About the Authors

Kitty Hurley is passionate about web map accessibility and bringing the web and maps to wider audiences. She is a senior product engineer with Calcite Design System. She enjoys exploring Minnesota's wilderness and wants to visit every Major League Baseball stadium across America.

Kelly Hutchins is a software developer on the ArcGIS Instant Apps team who builds apps that help share ArcGIS Online content. Outside of work, she enjoys spending time trail running with her dogs.

UNITING TO MAP A BETTER FUTURE

More than 21,000 GIS professionals from more than 130 countries gathered in San Diego, California, for the 44th Esri User Conference (Esri UC). The world's largest GIS conference was held July 15–19, 2024. It was four days of sharing, inspiring, connecting, and enjoying each other's company. The event featured hundreds of presentations, specialized training, networking opportunities, and information on the latest developments and best practices in GIS.

In his Plenary Address on the conference's theme, GIS—Uniting Our World, Esri president Jack Dangermond noted that the world is evolving rapidly—for better and worse—driven by human innovation.

However, the great progress humans have made as a species has come at a great cost to the planet—a cost that puts its sustainability in peril.

"We humans are living carelessly. As a species we are way over the line," said Dangermond. "Everyone needs to understand and work together to meet these challenges and unite around the powerful science of geography." Dangermond stressed that the situation is urgent, and the time to act is now.

However, humans possess a powerful tool: the geographic approach. "Geography organizes everything we know—all our experiences," said Dangermond. "This magical word 'where' is an extraordinary word because it connects all of humanity to all the science. The *where* is a powerful thing. It's your bridge to everyone else on the planet. It helps us see the world in interconnected ways."

GIS is the technology that operationalizes geography by providing a framework and process for collecting, measuring, visualizing, and supporting decision-making. It is expanding the language of geography and enabling mapping that helps make the complexity of the world more understandable. The distributed architecture of modern GIS is creating a geospatial infrastructure that is being embraced by thousands of organizations and transforming the way they work together.

Even with the power of GIS, Dangermond noted that meeting challenges to the Earth will take everyone. GIS professionals have an enormous role to play in influencing the future of the planet. It will require curiosity and courage to create holistic solutions that will deliver a better tomorrow, even as the world faces many challenges today.

Dangermond cited a quote by Ralph Waldo Emerson: "Among the map makers of each generation are the risk takers, those who see the opportunities, seize the moment, and expand man's vision of the future."

"Wow, he was talking about GIS people," said Dangermond. "We as a group can do exactly what Emerson said—unite our world and create a better future."

The theme of using GIS to unite efforts to create a better future for the world was also central to a special video message to the GIS community from Amina J. Mohammed, Deputy Secretary-General. Over the past four decades, GIS had empowered agencies across the United Nations to fulfill their missions and support the achievement of the Sustainable Development Goals (SDGs). GIS professionals are working with UN staff

to realize these goals.

"Geospatial information is not just a tool; it is a critical assets that helps us navigate the complexities of our world," said Mohammed. "It empowers us to see beyond the horizon, to understand the intricacies of our planet, and respond with precision and purpose."

After reviewing examples of the diverse and innovative application of GIS done by users in numerous organizations, Dangermond called attention to the 258 organizations receiving Special Achievement in GIS (SAG) Awards. These organizations were recognized for outstanding work in GIS.

In addition to the SAG Awards, each year three major awards—the Making a Difference Award, Enterprise GIS Award, and the President's Award—are presented during the plenary. The National Geospatial-Intelligence Agency (NGA), the largest geospatial organization on the planet, received the Making a Difference Award for its exceptional use of GIS to create a better world. The NGA relies on GIS to provide the geospatial intelligence (GEOINT) services that support decisions by the US president and US national policymakers.

The agency also helps federal agencies such as the Department of State and the Federal Emergency Management Agency in responding to natural disasters and humanitarian crises. In accepting the award, Vice Admiral Frank Whitworth lauded the work of the GIS community, saying, "There is not a group of professionals on this planet doing more for this planet or doing more to unite this planet. That applies whether we are trying to save the world from bad weather or protect it from bad actors or both."

The City of Raleigh, North Carolina, received the Enterprise GIS Award for its organization-wide embrace of GIS technology to improve efficiency and collaboration. The city used GIS to better access and consolidate department datasets and gain a more holistic, real-time view of city operations.

The President's Award is personally chosen by Dangermond and given to an organization that uses data-driven decision-making to impact the world in a positive way. The United States Agency for International Development (USAID) GeoCenter was honored with this award in recognition of its work using GIS to improve development outcomes.

Accepting the award was Carrie Stokes, USAID chief geographer and GeoCenter director, who founded the center in 2011 and oversees the work of its 70 geospecialists. She noted that the mission of USAID is to save lives. The GeoCenter uses GIS to target where needs are the greatest. Stokes thanked Dangermond for "helping us learn to map a better world."

The two keynote speakers told how they use GIS to understand and improve the sustainability of our world from financial and environmental perspectives. Governor Tim Walz, the first keynote speaker, has used GIS to enable a data-driven approach to solving challenges in Minnesota and supporting higher living standards for its residents. This address is explored in detail in an accompanying article in this issue, "The World We Want."

↑ Esri president Jack Dangermond urged GIS professionals to have the courage and curiosity to develop holistic strategies for creating a better future.

← More than 21,000 people attended the 44th Esri User Conference.

The second keynote speaker, Jeff Kerby, is an ecologist, photographer, and National Geographic Explorer who specializes in animals and plants in extreme environments from Greenland to Ethiopia. Currently, he is a senior researcher at the Scott Polar Research Institute at the University of Cambridge.

He has used photography as part of his research on monkeys in Ethiopia to capture data on his subjects and the landscape. He now conducts research in Greenland to understand seasonality and the interactions of temperature, vegetation, and carbon stores and their effects on climate change. Recent advances in imagery and 3D visualization in GIS that transform historic photographs into 3D scenes help him understand and document these changes over time. His presentation concluded with a stunning 3D visualization of a trip through the fjords of northeast Greenland as they would have appeared in the 1930s.

Presentations by organizations from

around the world demonstrated how they are using GIS to provide infrastructure for collaboration, cost savings, and the more efficient delivery of services.

Central San based in California, described how the ArcGIS Utility Network has improved its operations. Central San provides wastewater collection, treatment, and disposal services; recycled water production and distribution; and household hazardous waste collection for nearly half a million residents and more than 15,000 businesses in Contra Costa County, California.

Representatives of the Public Authority for Civil Information (PACI) explained how the agency has become the geospatial authority for Kuwait, using geospatial artificial intelligence (GeoAI) and reality mapping to produce authoritative data and develop apps and services to support the country's four million people and its thriving economy.

[For more information on PACI's innovative use of GIS, see "Machine Learning Becomes Part of Kuwait" (links.esri.com/PACI).]

Another national organization, the Urban Redevelopment Authority and National Parks Board of Singapore, depends on GIS for its operations. It is the foundation for an enterprise-focused system for planning and landscape management to realize Singpore's goal of creating a "City in Nature" so that green space is easily accessible to all residents.

With an areal land extent of approximately 1,900 square miles, the government of Miami-Dade County in Florida has a big job delivering services to its more than 2.7 million residents. ArcGIS Enterprise serves as the mechanism for residents and 30,000 staff members to discover and access government resources. It is the framework for the "No Wrong Door" initiative that makes sure no matter at what point residents touch the government, they seamlessly receive services. GIS also optimizes planning and maintenance of city infrastructure.

Representatives for The Crown Estate, United Kingdom, demonstrated how GIS enables its marine planning activities. The Crown Estate is an independent commercial business that manages the sovereign's hereditary possessions with the goal of creating lasting and shared prosperity for the nation. To fulfill this mission, The Crown Estate uses GIS to identify and optimize how resources are managed in the seabed off England, Wales, and Northern Ireland. Through scenarios built using GIS, The Crown Estate works at balancing competing and complementary uses of this area, protecting nature while supporting a flourishing marine economy.

Marriott International uses GIS to assess and mitigate security risks and plan adaptation strategies to deal with severe weather events and climate change at its more than 9,000 properties in 139 countries. The company is developing climate adaptation strategies to safeguard its properties. Marriott global intelligence staff use the Atlas app to access tactical information on real-time global hazards.

John Gillham, project manager and contractor for the United States Forestry Service, described a new cross-agency geospatial data sharing service that efficiently delivers, manages, and analyzes of high-resolution aerial imagery and raster data for the Forest Service, the US Fish and Wildlife Service, and the US Geological Survey (USGS). The Interdepartmental Imagery Publication Platform (IIPP) overcomes long-standing problems with heavily siloed systems in the federal government by using ArcGIS Enterprise on Kubernetes and ArcGIS Online. The service already hosts more than a petabyte of data and produces significant cost savings for all these agencies.

[For more on IIPP, see "Cloud-Based Approach Revolutionizes Interagency Imagery Sharing" in this issue.]

In the days following the Plenary Session, conference attendees had a host of activities to choose from: more than 700 paper and technical presentations; Lightning Talks; special interest group meetings; a vendor expo; and activities such as yoga, a 5K run, kids' fair, and the conference party.

← Carrie Stokes, USAID chief geographer and GeoCenter director, accepted the President's Award.

↓ Representatives of the Public Authority for Civil Information (PACI) explained how the agency has become the geospatial authority for Kuwait, using geospatial artificial intelligence (GeoAI) and reality mapping to produce authoritative data and develop apps.

The World We Want

Keynote speaker Governor Tim Walz

His two decades as a geography teacher have had a profound effect on Minnesota governor Tim Walz, the first keynote speaker at the 2024 Esri User Conference.

"Maps have had such a big influence in my life," noted Walz, who has been employing GIS to improve the quality of life for Minnesota's residents since his election as the state's 41st governor. These improvements include providing universal free school meals for students and laying the groundwork for Minnesota to generate 100 percent clean electricity by 2040. He believes that "the end product of these maps is a more sustainable economy, a more sustainable environment, and lifting up of people's lives in a way that they can thrive."

In describing his journey from geography teacher to governor, Walz cited a phrase used by Esri president Jack Dangermond: "Where you are has a lot to do with who you are." Walz grew up in a small town in western Nebraska—a town so small that of the 20 kids in his graduating class, 12 were cousins. As a teenager, he worked as a ranch hand by day and, at night, read old issues of *National Geographic* magazine and dreamed of faraway places. After graduation, he enlisted in the Army National Guard and served for 24 years. As an artillery officer, geography was a practical concern for Walz, who had to know exactly where he was on the earth's surface and exactly where everyone else was.

Walz became a high school geography teacher, teaching abroad and in the United States. His belief in the power of GIS dates to his first exposure to it in the early 1990s, when he received a handful of floppy disks while attending the National Geographic Summer Geography Institute. He took those disks back home, put them in his Mac 2E, and taught himself and his students GIS.

Using GIS, Walz helped his students understand the world's challenges. In one exercise that was an outgrowth of his work with the Holocaust Museum, he asked students to analyze economic, historical, and demographic data to predict where the next genocide would occur. His students predicted that place would be Rwanda. Events 12 months later sadly proved them prescient.

> "The tools of GIS and the science behind this and the tools to communicate really help unite people."

After retiring from the Army National Guard, he was elected to the United States House of Representatives in 2006 and was reelected for another five terms. During his time in Congress, he was constantly appalled by legislators' profound lack of geographic knowledge.

When he was elected governor of Minnesota in 2018, his belief in the power of GIS to convey complex information to affect change was validated during the COVID-19 pandemic. With the support of GIS analysis and communication tools, Minnesota had one of the highest rates of vaccination and lowest number of COVID-19 deaths.

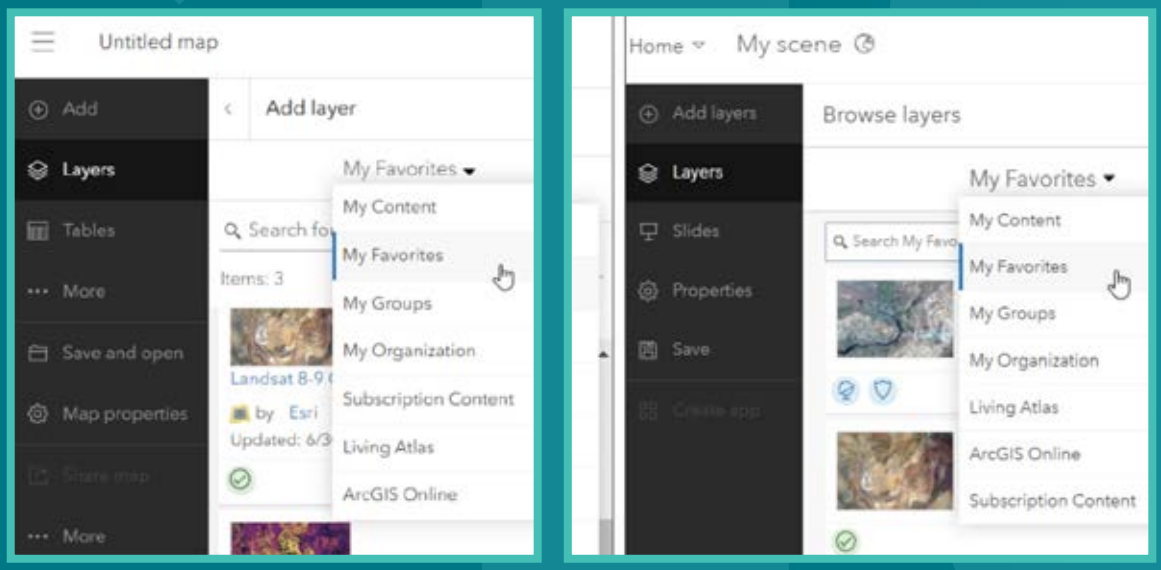
Minnesota has been a user of Esri technology for 49 years. Walz continues relying on GIS to pursue the triple bottom line: a state that is environmentally, economically, and socially sustainable. He sees GIS as critical to advancing this program because it helps communicate "aspirations that are so big that people just can't wrap their minds around the solutions."

However, effecting this positive change is not easy. "There is an entire cottage industry on dividing people and cynicism," said Walz. "Uniting is much harder. Bringing people together is much harder. The tools of GIS and the science behind this and the tools to communicate really help unite people."

To effect change, "you have to have a plan and the tools for that plan are GIS." GIS will enable the vision of a fair society to become a reality that delivers the world we want. Walz called on the GIS professionals in the audience to continue to be the visionaries that the world so desperately needs now.

Ten Ways to Get the Most Out of ArcGIS Living Atlas of the World

By Bern Szukalski



← Use My Favorites to bookmark ArcGIS Living Atlas of the World content. My Favorites are also built-in to ArcGIS Pro and ArcGIS StoryMaps workflows.

ArcGIS Living Atlas of the World basemaps are the foundation for almost every map or app in ArcGIS, whether used in a browser or on a device. Its layers—such as live feeds, environmental layers, and demographic information—complement and add context to your operational layers.

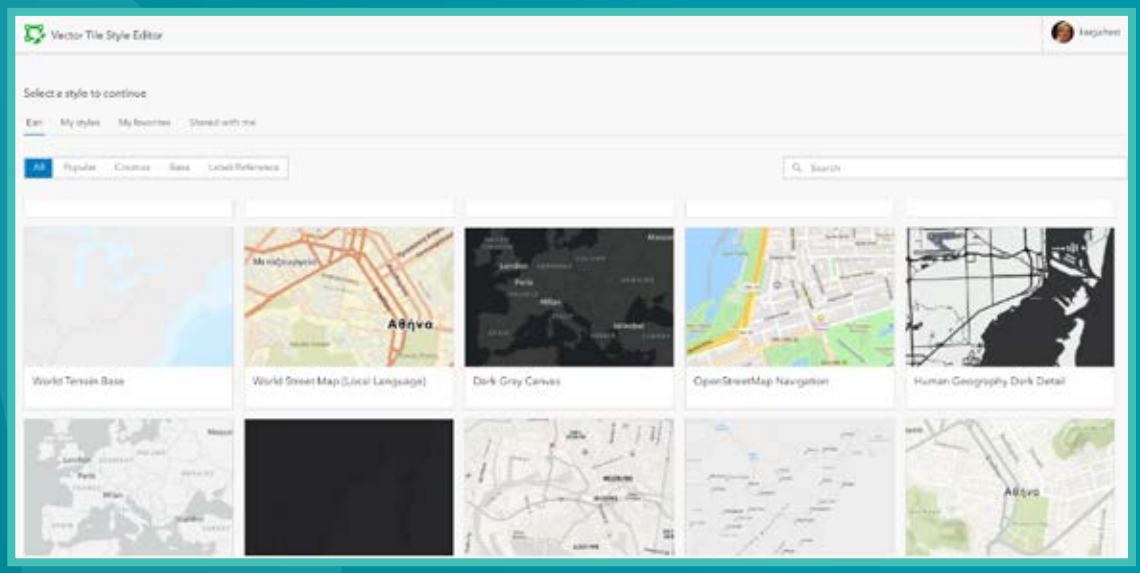
The foremost collection of curated geographic content, ArcGIS Living Atlas includes ready-to-use basemaps, maps, layers, apps, and tools from Esri and the global GIS user community. It is integral to the ArcGIS system, so whether you are using ArcGIS Online, ArcGIS Enterprise, ArcGIS Pro, or other ArcGIS apps, ArcGIS Living Atlas is an inherent part of your mapping activities.

The valuable resources available from the ArcGIS Living Atlas website can be leveraged in many ways. Here are 10 suggestions for getting the most out of ArcGIS Living Atlas in your work and workflows.

1. Begin map authoring at the ArcGIS Living Atlas website.
2. Use My Favorites to bookmark ArcGIS Living Atlas content.
3. Extend your basemap gallery.
4. Use a custom ArcGIS Living Atlas basemap.
5. Use ArcGIS Living Atlas apps.
6. Use ArcGIS Living Atlas to learn techniques.
7. Use (and share) advanced search capabilities.
8. Make your maps come alive using live feeds.
9. Use ArcGIS Living Atlas content for visualization and analysis.
10. Contribute to ArcGIS Living Atlas.

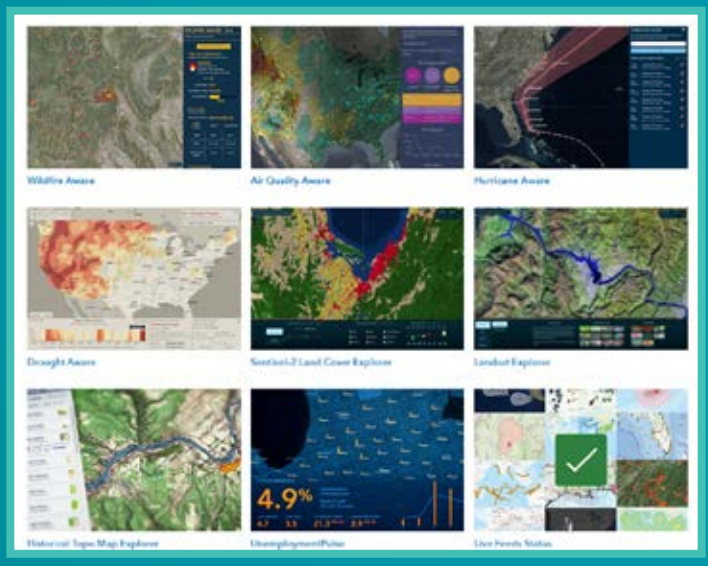
1 Begin map authoring at the ArcGIS Living Atlas website.

If you sign in to your account at the ArcGIS Living Atlas website (livingatlas.arcgis.com/en/home/), you can open the Browse tab to search for layers to begin authoring your maps and scenes. The Browse tab provides comprehensive search and filtering tools to



← Using ArcGIS Vector Tile Style Editor, you can customize any ArcGIS Living Atlas basemap for use in your organization or for use in a map or app.

→ Click the Apps tab at the ArcGIS Living Atlas website to view all highlighted apps.



help find maps, scenes, or layers to begin your work. Look for Sign In located in the upper right of the page.

Click options (…) on the item card to open the layer in Map Viewer, Scene Viewer, or ArcGIS Pro, or click the thumbnail or title to view the item pages and open it from there. Because you are signed in, you can continue authoring the map and save it to My Content when finished.

2 Use My Favorites to bookmark ArcGIS Living Atlas content.

Use My Favorites to streamline your authoring workflows across the ArcGIS system. Go to ArcGIS Living Atlas Browse tab and sign in. Use search, then favorite what you find for quick access. My Favorites are built-in to the Map Viewer and Scene Viewer authoring workflow, making this a handy technique to find ArcGIS Living Atlas layers without needing to go back and search again. My Favorites are also built-in to ArcGIS Pro and ArcGIS StoryMaps workflows.

3 Extend your basemap gallery.

ArcGIS Living Atlas has lots of interesting and useful basemaps that aren't included in the Esri defaults for your organization. Administrators can find more basemaps to add to their organization's custom basemap gallery at the ArcGIS Living Atlas website. In the Creative Vector Tile Layer and Web Maps group (links.esri.com/creativeVector), you will also find more basemaps from the ArcGIS Living Atlas team you can use.

4 Use a custom ArcGIS Living Atlas basemap.

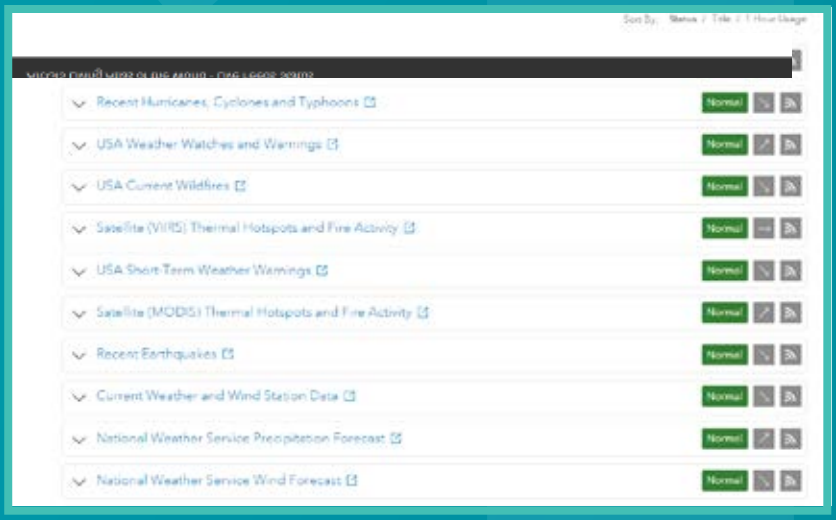
Using ArcGIS Vector Tile Style Editor (links.esri.com/VectorTileEditor), you can customize any ArcGIS Living Atlas basemap for use in your organization or for use in a purposeful map or app. You can change colors, simplify the map, highlight certain aspects, and manage labels and symbols to create a unique style. For more information, see the Vector Tile Style Editor documentation (vtse.arcgis.com/documentation/). The Creative Vector Tile Layers and Web Maps group contains examples and maps that you can start with.

5 Use ArcGIS Living Atlas apps.

Content from ArcGIS Living Atlas of the World is used to make stunning, valuable apps for visualization and analysis. Most of the apps are intended to be used as is to learn more about a topic, such as wildfires, air quality, and drought conditions. Some examples of these apps are:

- World Imagery Wayback
- USGS Topographic Map Explorer
- AirNow

View all highlighted apps by clicking the Apps drop-down at the ArcGIS Living Atlas website.



↑ The Live Feed Status page displays a summarized view of commonly used live feeds, showing their current status and usage trend, along with an RSS link to subscribe to notifications.

6 Use ArcGIS Living Atlas to learn techniques.

ArcGIS Living Atlas maps, apps, and layers leverage the very best techniques and tradecraft to turn data into expressive displays of information. These tools include using custom basemaps, applying focus and interest using styles, blending, and effects, and creating eye-catching informational pop-ups.

Open a map or layer, select the layer, then on the Settings (light) toolbar, look at Blending (in Properties), Styles, Effects, and Pop-ups to see how it's been crafted.

The Esri GitHub repository is available for some of the ArcGIS Living Atlas apps, letting you download the app source code and learn how the app was created or customize it. From the ArcGIS Living Atlas app gallery, click the thumbnail to View app details. Then look for the Download button to take you to the repository.

7 Use (and share) advanced search capabilities.

Using the Browse tab at the ArcGIS Living Atlas website, you can quickly search and filter for specific content. Click Search Examples to see examples of how you can search. Filter by content type (e.g., maps, layers, scenes, apps, tools), date, region, and whether the content is from Esri or is marked as Authoritative. Use the drop-downs to narrow your search. You can share your filtered search results with others by copying the URL at the top of the page.

8 Make your maps come alive using live feeds.

ArcGIS Living Atlas includes authoritative live feeds that help you monitor and learn more about current and predicted conditions. These cover a broad range of topics such as earthquakes, wildfires, weather, thermal hot spots, and streamgauges. View all authoritative live feeds at https://www.esriurl.com/LiveFeed.

To provide more visibility and transparency for the current status of these feeds, the ArcGIS Living Atlas team has developed the Live Feeds Status page (livingatlas.arcgis.com/livefeeds-status/). This page displays a summarized view of commonly used live feeds, showing the current status and usage trend, along with an RSS link to subscribe to notifications.

The live feeds are updated every few minutes to every few months, depending on content and source; view the item pages for update details. Live feeds are implemented using the Aggregated Live Feed methodology (links.esri.com/LiveFeedMethodology), a proven technique that you can implement for your own feeds.

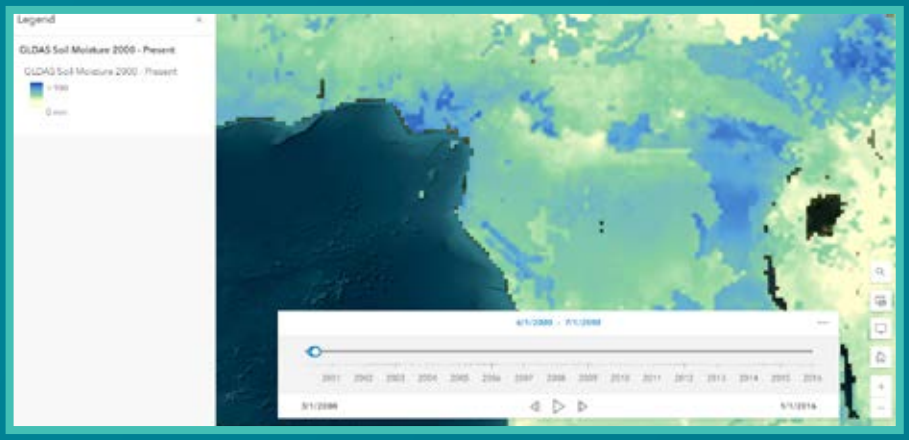
9 Use ArcGIS Living Atlas content for visualization and analysis.

ArcGIS Living Atlas provides access to apps, tools, and high-quality GIS data that can be used to visualize events or perform analysis. Analysis can be performed directly in Map Viewer, ArcGIS Image for ArcGIS Online, and ArcGIS Pro.

Use ArcGIS Living Atlas layers to perform spatial analysis, such as buffering, overlay, and proximity analysis. Aggregating point data and missing geographic boundaries? ArcGIS Living Atlas has a collection of ready-to-use boundaries for your work that can be

↑ Use elevation data to perform terrain and 3D analysis and combine that analysis with 3D layers to create visualizations of cityscapes or the natural environment.

→ Use the multispectral and multitemporal imagery available from the Environmental section to view land use and land cover to understand change over time.



accessed from the Boundaries drop-down on the Browse tab.

ArcGIS Living Atlas includes a wide and comprehensive range of demographic data that can be used to understand your community, perform site selection, locate facilities where they are needed, and enrich your own data. See all ArcGIS Living Atlas demographic content by clicking the Demographics drop-down on the Browse tab, or take the Learn about your community using Census ACS layers in ArcGIS Living Atlas tutorial at links.esri.com/ACStutorial.

Key environmental data, such as elevation, soils and geology, land cover, climate data, and others found in ArcGIS Living Atlas can be used to assess environmental impact, understand ecosystems, view protected areas, evolve natural resource management, examine climate resilience, and more. See all ArcGIS Living Atlas environment content by clicking the Environment drop-down on the Browse tab.

Use various types of multispectral and multi-temporal imagery to view land use and land cover, understand change over time, and use different processing templates to focus on specific information.

Access pre-trained deep learning models to extract specific features of interest from imagery or use raster function templates to enhance imagery or create intuitive visualizations over time. See all ArcGIS Living Atlas tools at links.esri.com/LAtools.

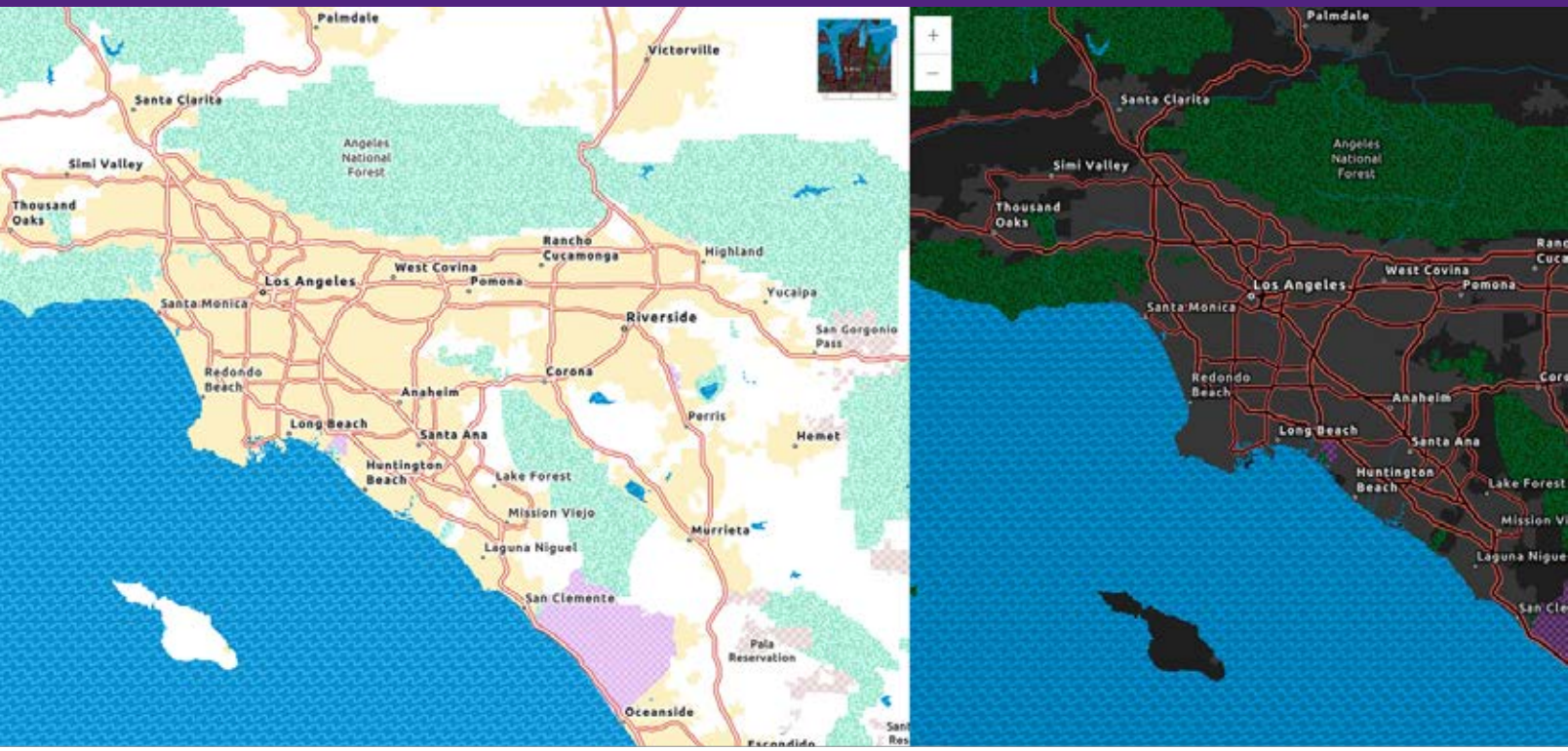
10 Contribute to ArcGIS Living Atlas.

You can contribute to ArcGIS Living Atlas by participating in the Community Maps Program (communitymaps.arcgis.com/home/). Organizations around the world contribute their local geographic knowledge to the Community Maps Program because they understand that an accurate and useful basemap foundation is of paramount importance.

Contemporary basemaps ensure the creation of higher quality information products and support better decision-making. Participating organizations can access to a rich collection of accurate, beautifully styled basemaps created by authoritative data providers and GIS users around the world, provide feedback, edit features, and share data to contribute to the greater GIS community.

About the Author

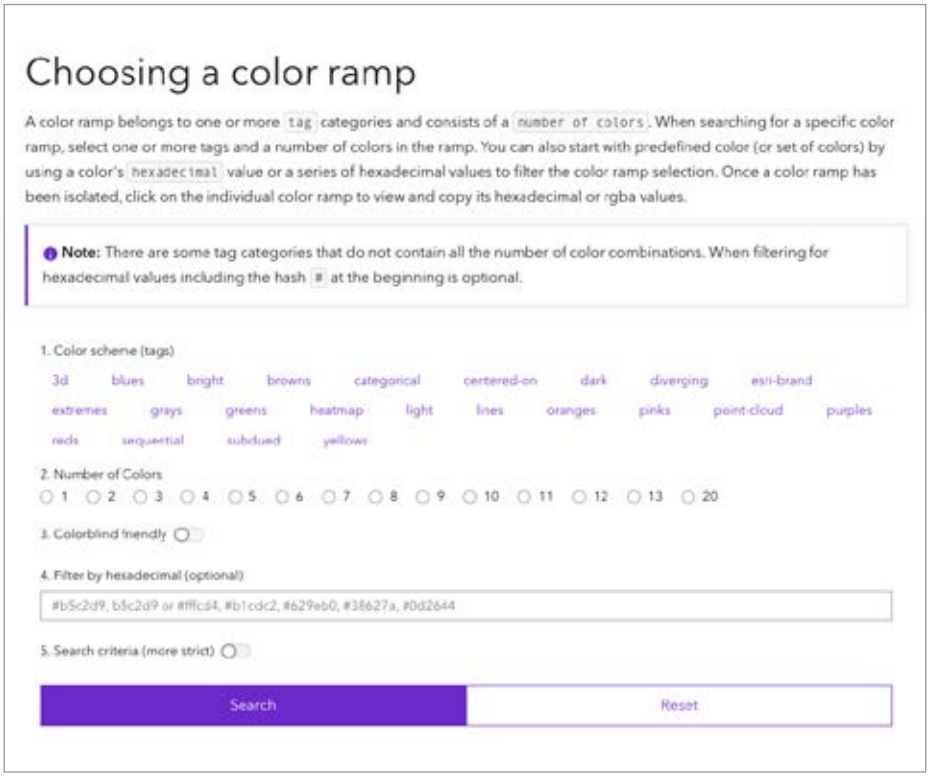
Bern Szukalski is a corporate technology evangelist and advocate at Esri who focuses on ways to broaden access to geographic information and helping customers succeed with the ArcGIS system. On a good day he is making a map, on a great day he is on one.



ACCESSIBILITY ESSENTIALS for GIS and Mapping

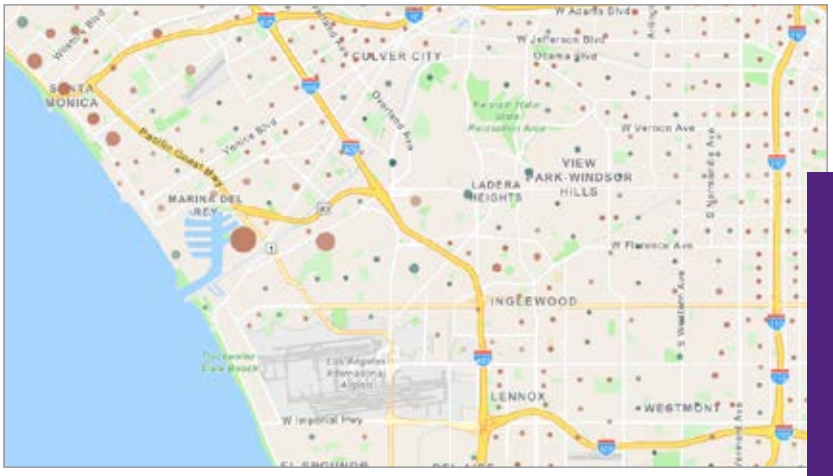
By Jessica McCall and Krista McPherson

The information and data conveyed in GIS maps and apps should be accessible to everyone. Implementing digital accessibility in GIS and mapping helps reduce barriers for people with disabilities and ensures the widespread availability of information. However, digital accessibility in GIS and mapping can pose several challenges due to the inherently visual nature of the data. By utilizing some practical guidance to enhance maps and apps, accessibility can be improved using any application across the ArcGIS system.



↖ The Enhanced Contrast basemaps can provide additional color contrast and visibility to a map.

↙ The Esri Color Ramps guide on the ArcGIS Developers site helps you create custom color ramps that are color-blind friendly.



← Maps with standard symbolization can be modified to accommodate persons with CVD.

↓ Color modifications in ArcGIS Pro for persons with (A) deuteranopia; (B) protanopia; and (C) tritanopia.

Basemap Selection

Choosing an appropriate basemap is important to showcase the data in the most accessible way possible. If the data featured uses lots of symbols and colors, consider exploring options for a more muted basemap such as the Light Gray Canvas or Human Geography Map. However, if detailed street data is needed for better context, consider the Enhanced Contrast Map and Enhanced Contrast Dark Map basemaps.

After choosing the basemap, consider if there are aspects of the basemap that need to be edited to ensure a clean, clear, and concise application. Using the Vector Style Editor to edit or remove certain characteristics can support an uncluttered basemap for the data.

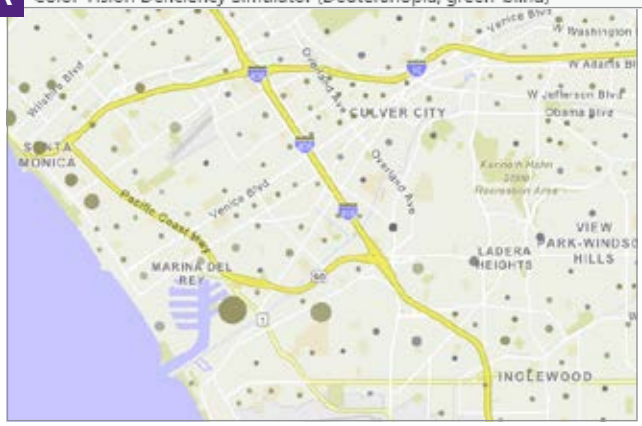
Color Scheme Selection

Selecting, managing, and editing the colors that are used throughout the map or app is a significant part of ensuring accessibility. Choosing a good color scheme and deciding which colors should be used in symbology and labels is critical to contrast and a more accessible map.

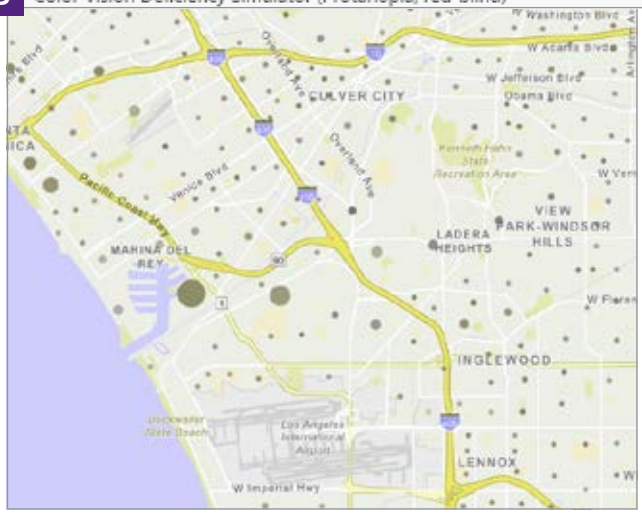
When selecting a color scheme to represent continuous data, it is important to consider how the data is being displayed. The thematic set of colors chosen should have good contrast within the data's variation, order, sequential values, or categories on the map. Better contrast between colors supports those with low vision or color vision deficiency (CVD) and can provide interest and depth to the data.

There are several options throughout the ArcGIS system for choosing color schemes. In ArcGIS Pro, the map can be changed to use either the RGB or CMYK color model and the default ColorBrewer Schemes provide an assortment of

A Color Vision Deficiency Simulator (Deuteranopia, green-blind)



B Color Vision Deficiency Simulator (Protanopia, red-blind)



C Color Vision Deficiency Simulator (Deuteranopia, green-blind)

color-blind-safe color schemes. In ArcGIS Online and ArcGIS Enterprise, there are multiple color ramp options to choose from the drop-down menus and categories that show the best options for color-blind-friendly color ramps. Additionally, the ArcGIS Developers site has a tool, the Esri Color Ramps guide (links.esri.com/ColorRampGuide), that helps you create a color-blind-friendly color ramp using a variety of choices and filters.

Testing for Color Vision Deficiency

CVD affects about 300 million people worldwide, which includes approximately 8 percent of men. Testing color contrast supports a design process for creating any map, website, or application that is inclusive of individuals with CVD. Color contrast testing is essential in GIS and mapping due to the frequent use of multiple adjacent colors.

In ArcGIS Pro on the View tab in the Accessibility group, select the Color Vision Simulator drop-down list to utilize filters for testing your map. The options in the Color Vision Deficiency tool can show how the colors on the map would be viewed by someone with CVD. These filters can aid in determining how to adjust the color ramps to support better contrast. For additional information on using the Color Vision Deficiency simulator in ArcGIS Pro, see the documentation at links.esri.com/CVDsim.

If working in ArcGIS Online or another web application, a color filter app can be downloaded as a web browser extension. These browser extensions filter the view to show how colors might be interpreted by someone with CVD.

Colors in Symbology

When choosing a color scheme for discrete data in a map that may be represented in points or lines, the same color contrast and use of CVD filters applies. However, it is important to recognize the additional factor of not letting color be the only representation of the data. If a map is created with only color to differentiate between various data points, the understanding of the data could become challenging not only for those with CVD, but also for those with other neurodivergent disabilities. As a best practice, in addition to color, choose symbols, icons, patterns, and/or point sizes that can make it easy to distinguish data points.

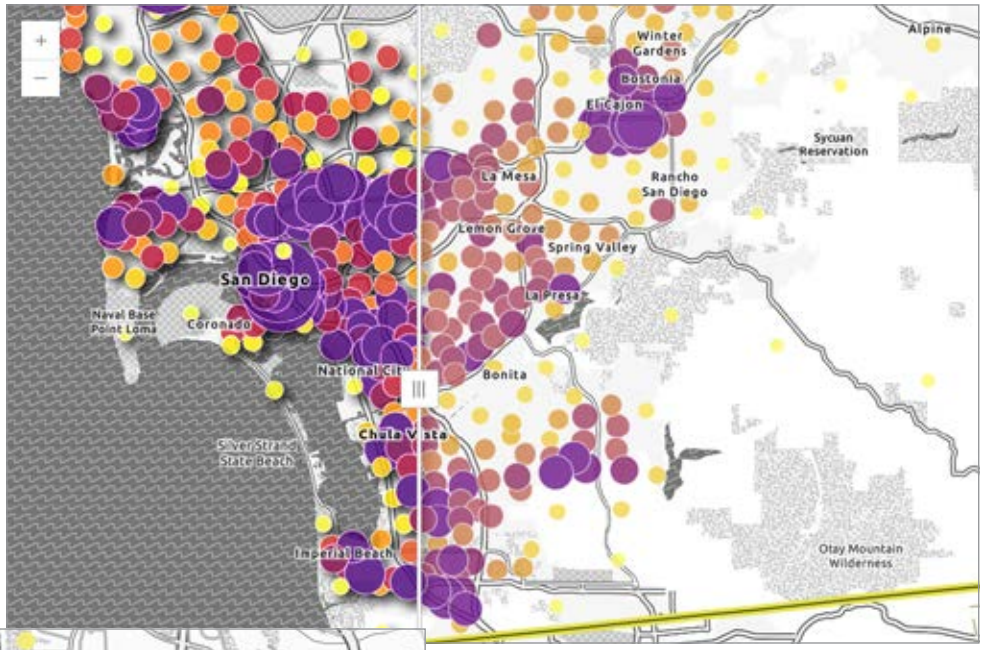
Labels and Areas of Interest

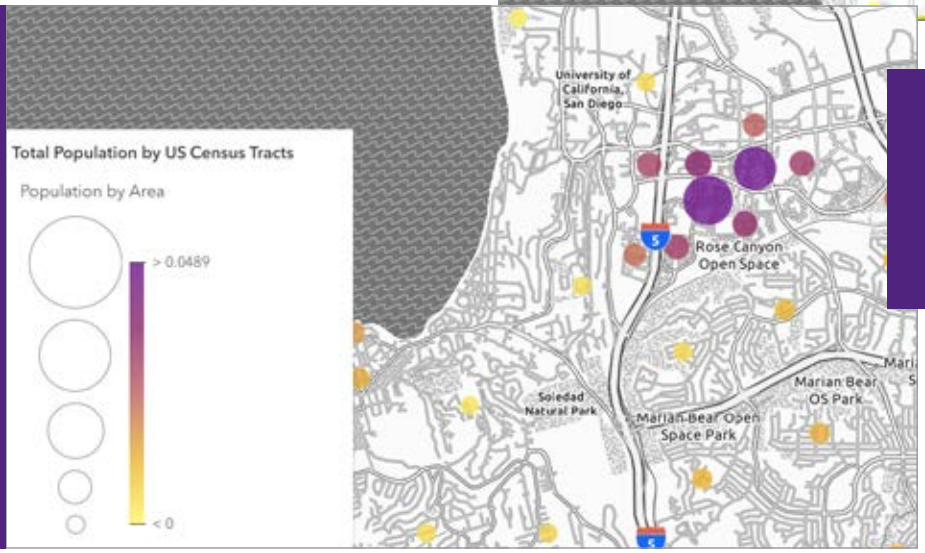
Ensuring good contrast and clarity in labels on the maps can add to better understanding of the data and good accessibility for all audiences. To ensure readability of the labels, authors can edit the size, color, and font to enhance the understanding of the data. Labels can be edited in the basemap or as a new layer. Halos can be used on the labels to increase contrast between the underlying basemap or the data.

It may also be beneficial to emphasize an area of interest by adding further contrast and reducing visual clutter. This strategy can keep the map clear of distractions and emphasize the data that you want to highlight.

Alternative Text and Map Descriptions

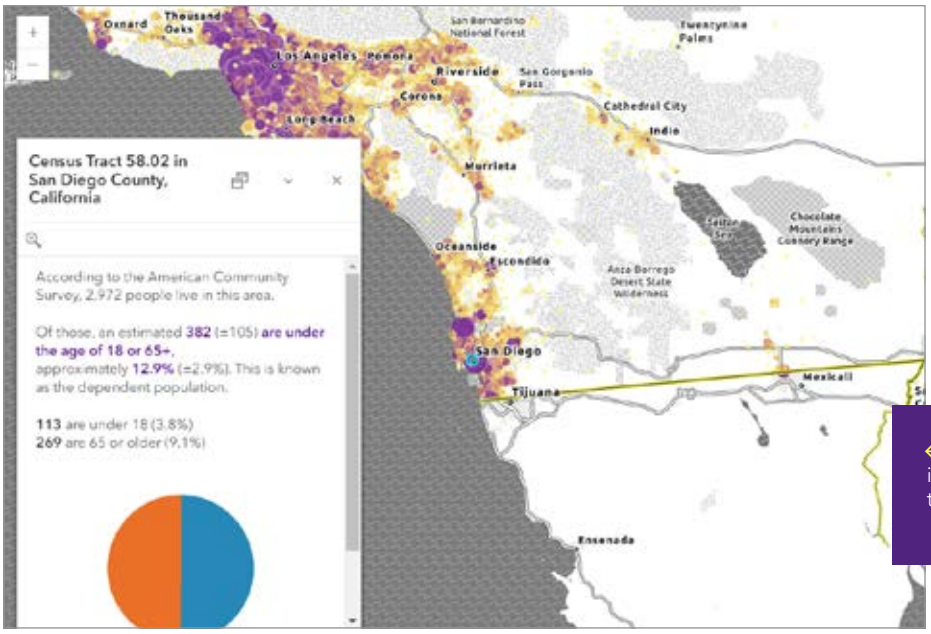
Ensuring that all non-text content has a text alternative that serves the equivalent purpose of the visual is an accessibility best practice. Alternative text is meant to provide a programmatic description





↑ Symbology with good color contrast supports better understanding and clearer display of the data.

← Reducing visual clutter will emphasize the data that you want to highlight on the map.



← Adding pop-ups with relevant information lets users better understand the data shown in the map.

for the image or map that a screen reader can announce. A caption should provide the context for the image or map as it pertains to the placement of that image in the text.

For example, the alternative text for a map of San Diego County, California, that illustrates the value of simplifying a map might be "Map of San Diego, California, showing population information and how it can be enhanced for improved contrast," while the caption could be, "By using effects in a map, visual clutter can be reduced to support better visibility of the map."

In GIS and mapping, the amount of information that needs to be represented can be significant and variable depending on the interactivity of the map. However, by providing some descriptive details in a narrative, the map author can help provide others with more comprehensive context about the map.

Provide Different Ways to Access Data

Offering data in different formats supports accessibility by allowing individuals to choose how to interact with the data. This strategy can be employed in a variety of ways across the ArcGIS system. Often data can be displayed as a table or exported to another format. While a data table might work for some data, long lists of data and values can be challenging to interpret. Formatting pop-ups to include the most essential information can boost understanding and clarity.

Conclusion

Accessible design in maps helps everyone better understand the data displayed and improves the experience for all. With a little planning and consideration of the design throughout the development cycle, map authors can take steps to ensure the accessibility of their content and data.

More Resources

Designing Web Maps for Accessibility (links.esri.com/AccesibilityDesign) is an ArcGIS Instant Apps portfolio that demonstrates accessibility in action. Explore these examples to learn where accessibility was prioritized and what product features best support inclusive access.

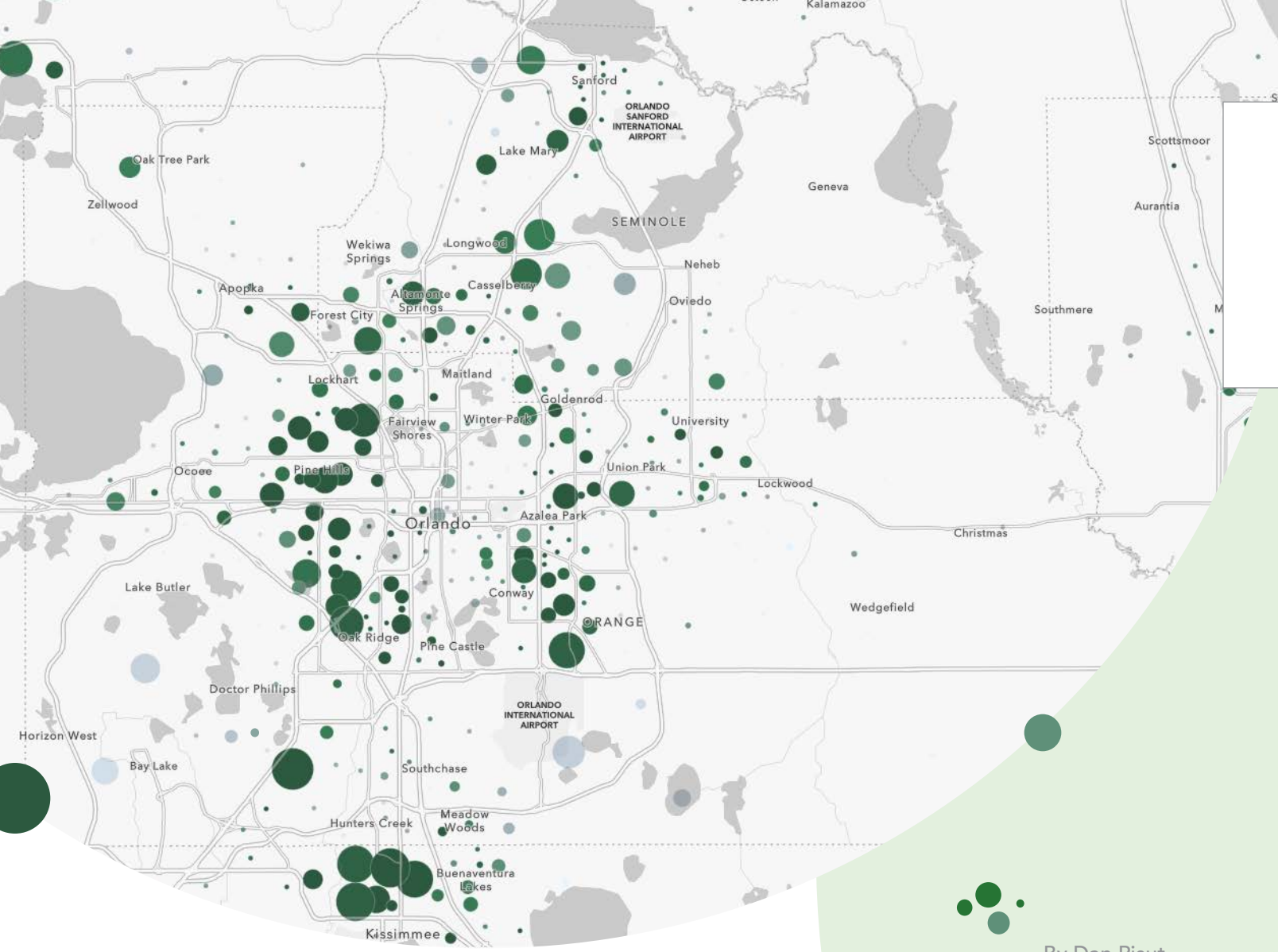
Read the following blog posts to learn more about accessibility features and strategies:

- "Working with Enhanced Contrast basemaps to improve accessibility" (links.esri.com/ContrastBasemaps)
- "Red…Green…What?" (links.esri.com/RedGreen)
- "Accessible Labels with ArcGIS Web Apps" (links.esri.com/AccessibleLabels)
- "Designing and testing for accessibility in GIS and mapping" (links.esri.com/AccessiblityTesting)

About the Authors

Jessica McCall is the senior accessibility project manager for the Esri accessibility team and manages strategic planning and project management activities for the team. She also works to gather and support customer requirements for accessibility alongside product team members. Previously, she worked for a consulting firm as a project and operations manager supporting utility data migration and data integration projects between GIS and CAD-based software.

Krista McPherson is a product engineer on the ArcGIS Instant Apps team.



By Dan Pisut

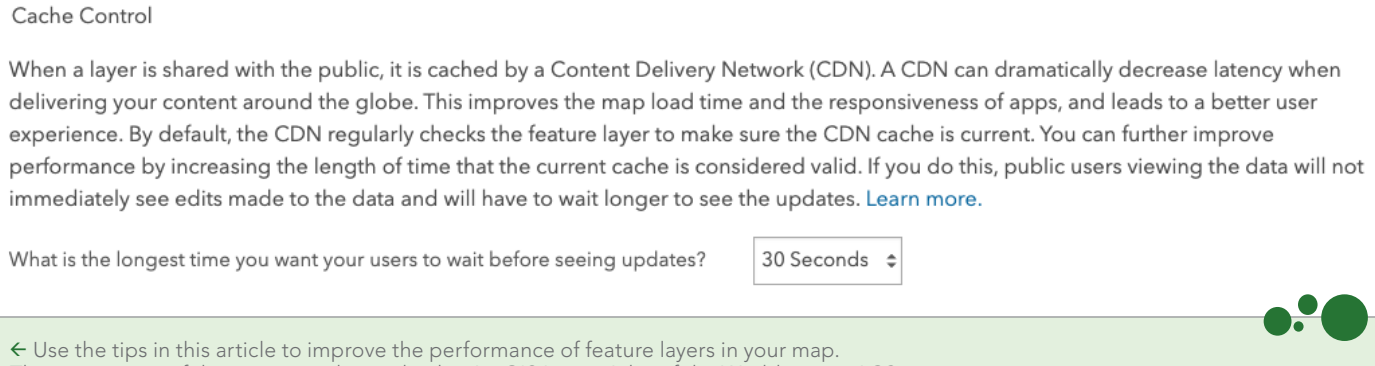
Top Five Tips to Improve Feature Layer Performance

Have you ever opened someone's web layer and watched as it struggled to draw or needed a few seconds to generate that pop-up? In contrast, layers like American Community Survey data from the US Census Bureau or hurricane forecast data appear as fast as lightning.

While it can take some real skill to quickly display large, complex datasets, improving performance for simpler layers can be boiled down to five tips described in this article. They take only a few minutes to implement and will greatly improve the performance of your web layers.

1 Strip It Down

Do you need all those fields? Does the data really need six decimal places? Make the data neat and compact. When possible, use integer instead of floating point for number formats. Round floating points to some reasonable precision. Reduce the maximum number of characters in a string length. If you imported data from Microsoft Excel, the fields default to 32,767 characters. This will choke your service. Also, remember that some fields can also be calculated on the fly with ArcGIS Arcade if the data is only needed for pop-ups or symbology. This technique makes the table smaller and easier to load.



← Use the tips in this article to improve the performance of feature layers in your map. These are some of the same tips that make this ArcGIS Living Atlas of the World map—*ACS Household Income Distribution Variables–Centroids*—so responsive.

↑ Bump up the Cache Control setting from the default 30-second interval to perhaps an hour, unless the layer's data is rapidly updating.

2 Add Attribute Indexes

Every time a pop-up is generated, the client queries the server. The same thing happens when symbology is drawn or changed, or a dashboard graphs data. Adding attribute indexes to any field a user might query, filter, or use in a pop-up or for symbology will greatly diminish performance. In layer settings, go to manage indexes and configure field indexes. You can also use the Add Attribute Index tool in ArcGIS Pro.

3 Run Optimize Layer Drawing

You have a layer in ArcGIS Online that was either published from ArcGIS Pro or uploaded from a geodatabase. (Note: Do not publish from ArcMap.) Now what? After fully configuring its content item, head to the Settings tab. In the Feature Layer section, click the Optimize Layer Drawing option and let that run for a few minutes.

4 Check Cache Control

After Optimize runs, scroll down to Cache Control at the end of the Settings page for the item. *[Publicly shared data is cached by the Content Delivery Network (CDN) to decrease latency in content delivery.]* You'll see the cache is set by default to 30 seconds. If your data is updating quickly, keep that setting. Typically, data updates aren't run every few minutes. For most layers, crank that interval up to one hour. That means that any view, zoom level, or query that someone makes will be held in memory for one hour.

5 Be Careful with Custom Symbols

ArcGIS Online has some great symbol options, but sometimes you need to personalize the layer a bit more. If you go down this road, tread carefully. Here are a few best practices when using custom symbols:

- Don't use lots of different custom symbols that will require many queries to draw the layer.
- ArcGIS Online accepts SVG formats, which is your best choice. Otherwise, use raster images that are no larger than 120 × 120 pixels.
- Export raster images as 8-bit PNGs with transparency. Even better, if symbols have only two colors, export as 4-bit PNGs. Adobe Photoshop has an 8-bit export format available. Choose File > Export > Save for Web (Legacy). It works well if you're not familiar with programs such as ImageMagik.
- Apply the image on the Visualization tab of your layer or view of the item instead of the service itself. This trick prevents the image from being converted to a text-encoded image in the service.
- Make sure your image is simple and legible at different scales. Read "Shopping for the Map's Meaning" (links.esri.com/shoppingmap) for more tips on styling point symbols.

Go forth and update your layers with these tips to make everyone's maps and apps work better.

About the Author

Dan Pisut leads development of ArcGIS Living Atlas of the World environmental content, which includes information about Earth's land, ocean, atmosphere, and ecosystems. Prior to coming to Esri, he worked at the National Oceanic and Atmospheric Administration (NOAA) for two decades, where he led data visualization efforts for research, communications, and education.

Mind the Map: A New Design for the London Underground Map

By Kenneth Field

In a 2019 blog, I explained how you can make a schematic transit map in ArcGIS Pro. The principles for production remain, but I always had a nagging feeling that the map I made, showing my reimagination of the famous London Underground map, didn't quite cut it. Time to give it another go!

In May 2022, ahead of the 90th anniversary of Harry Beck's original London Underground diagram, the new Elizabeth Line was opened. To me, this added more complexity to an already convoluted map. It is congested, with often overly complicated route directions and intersections. The colors no longer make sense with the multiple forms of transit being shown on the same map, and the distinction between them lacked coherence. The uniform line thickness suggests equal service throughout the network, which is not the case as frequency of service can vary between 30 trains an hour to 1 train an hour. This is information that could be designed into the map's graphical language.

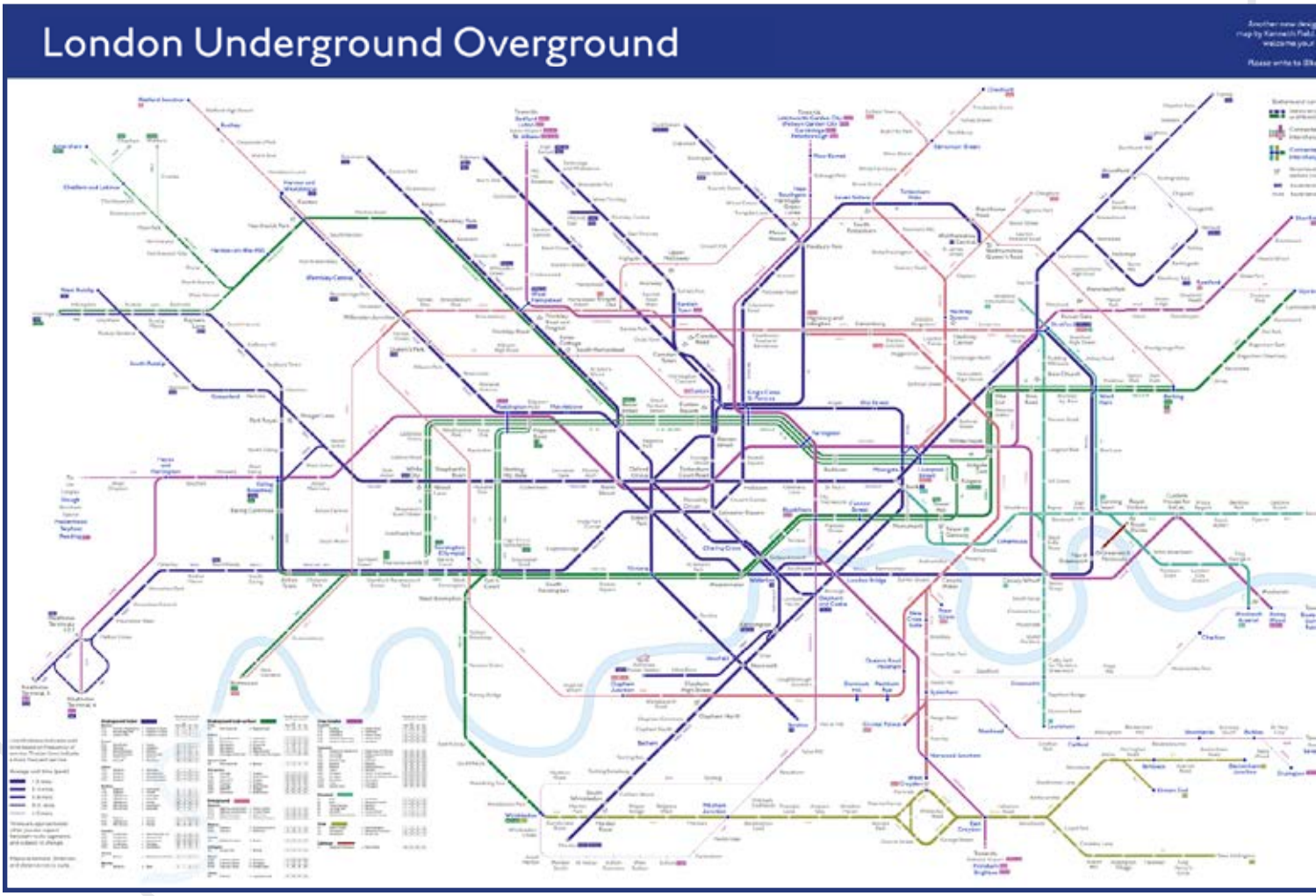
So, I redesigned my redesigned map from that earlier blog.

This new map demonstrates what a totally redesigned schematic layout might look like. It simplifies the organization of lines and station intersections. Accompanying illustrations show the upper left section of the map.

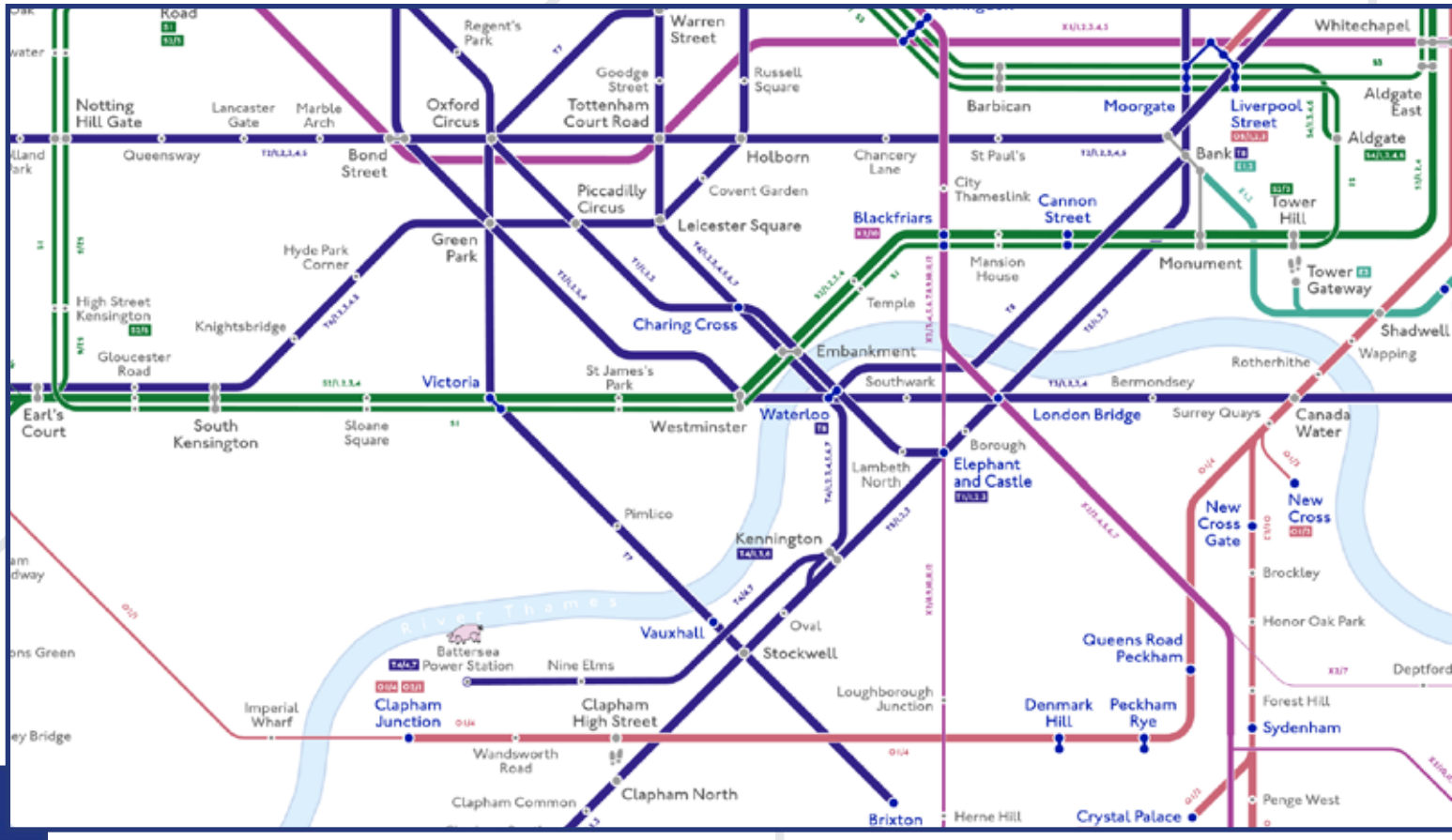
It uses different font treatments to encode different types of stations (such as interchanges and connections to National Rail services) as well as a redesigned treatment for station symbols. It also demonstrates a new color scheme for the lines based on mode of transport to replace the randomness of the iconic, though confusing, traditional scheme.

The map adds route information alongside lines and in an accompanying table, because not every route segment on a named line travels the full extent or even pairs the same origin and destination. And finally, it encodes frequency of service (expressed as average wait time) by scaling the thickness of route segments to give a sense of how long you might have to wait for your service.

It's a familiar expression of the famous



↓ The redesigned map uses different font treatments to encode different types of stations as well as a redesigned treatment for station symbols.



← The totally redesigned schematic layout simplifies the organization of lines and station intersections.

London Underground map, but it also makes many changes that bring additional information to the user by using a modern, cleaner, more consistent, and visually accessible schema for those with different color vision.

Download the actual map at links.esri.com/undergroundmap. Let me know what you think of it and whether you find the Easter eggs.

Happy schematic mapping!

About the Author

Kenneth Field is an academic cartographer and geographer from the United Kingdom who teaches, talks, and writes about cartography and makes maps that demonstrate map design at Esri. He considers himself a professional "cartonerd," and he received a bachelor's degree in cartography and a PhD in GIS and health geography. He has more than 30 years' experience designing curricula and teaching map design and GIS. He has presented and published an awful lot and is in demand as a panelist and keynote speaker. He blogs (cartoblography.com) and is a past editor of *The Cartographic Journal* (2005–2014), and past chair of the International Cartographic Association (ICA) Map Design Commission (2010–2018). He has won a few awards for maps, pedagogy, and kitchen tile designs. Fields is the author of the best-selling books *Cartography.* and *Thematic Mapping* and leads the Esri massive open online course (MOOC) on cartography, which has been taken by more than 200,000 students who are interested in making better maps. He also snowboards, plays drums, builds LEGO, and supports Nottingham Forest.

Historical USGS Topo Maps to Explore and Use

An updated version of the Historical Topo Map Explorer app (livingatlas.arcgis.com/topomapexplorer) lets you explore more than 180,000 historical US Geological Survey (USGS) topographic maps. Available from ArcGIS Online, it provides easy access to Esri's USGS Historical Topographic Map collection, which contains quadrant maps dating from 1879 to 2006 at scales from 1:10,000 and 1:250,000 (excluding orthophoto quads). The new app provides access to 1,745 new maps and corrected versions of maps previously available in the 2014 version of the app.

↑ Search results are presented in the sidebar chronologically. Clicking on a map will display an outline of its extent.

↑ Adjust the transparency slider to compare a historical map to current conditions.

→ View and pin adjacent historical maps and save them to collections for later reference.

Maps in Esri's USGS Historical Topographic Map collection are part of the USGS Historical Topographic Map Collection (USGS HTMC). Starting in 2011, the USGS National Geospatial Program began publishing scanned maps printed between 1884 and 2006 that were created using traditional cartographic methods and lithographic printing processes. Esri's USGS Historical Topographic Map collection contains scanned maps that were published as an ArcGIS Online image service.

Using the Historical Topo Map Explorer app, you can search for maps by address or place or interactively from the map. The results are displayed in chronological order. Filter results by geographic extent, publication year, and map scale.

The updated app released in February 2024 adds new functionality. You can adjust the transparency of the topo map to see how it relates to current map features. You can also overlay historical maps on satellite images or 3D hillshades and add labels for current geographic features.

You can pin and view adjacent historical maps to collections that you can save and refer to later. By pinning maps of the same location from different times, you can use the app to generate an animation that shows how an area and the cartography of those maps of that area have changed over time. You can download that animation as a video that can be exported and shared in a presentation or via social media.

By activating the satellite and/or terrain layers, you can view historical topo maps in even greater context. Access and copy metadata for individual maps by hovering over the *i* icon.

The scanned maps you find using the Historical Topo Map Explorer app can be used with maps in ArcGIS Pro, ArcGIS Online, and ArcGIS Enterprise. Maps can also be downloaded as georeferenced TIFs and used in other applications.

For a demonstration on how to use the Historical Topo Map Explorer app, watch the John Nelson video at links.esri.com/Histopo.

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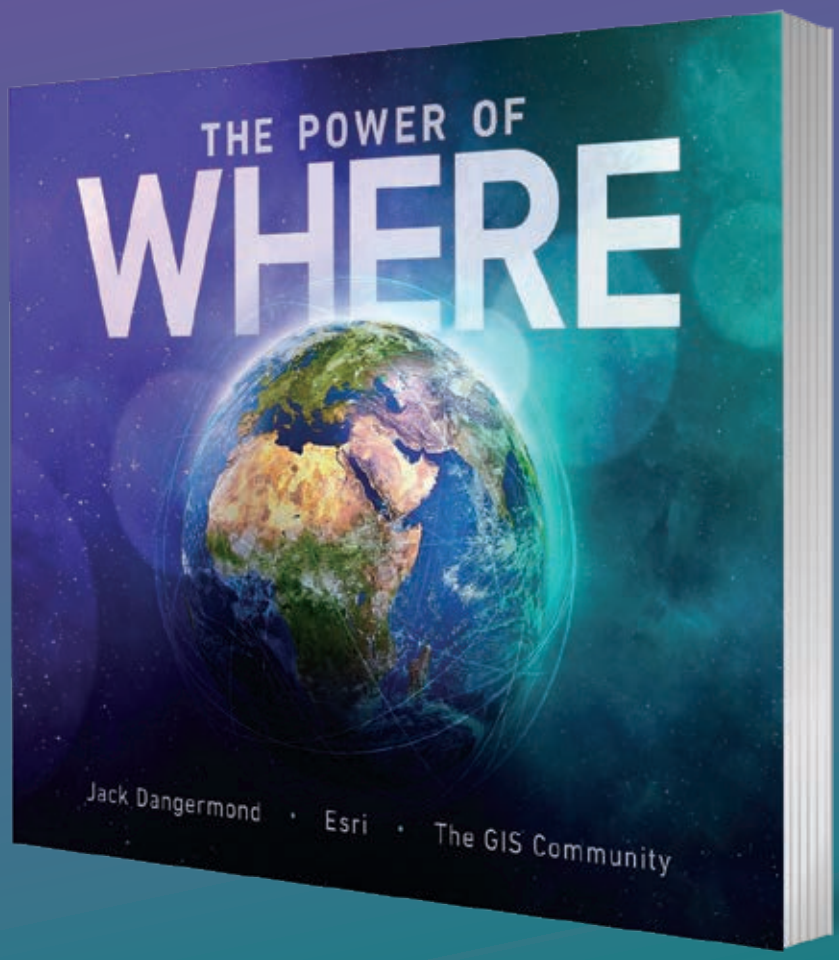
The Power of Where: A Geographic Approach to the World's Greatest Challenges

By Jack Dangermond



In *The Power of Where: A Geographic Approach to the World's Greatest Challenges*, author Jack Dangermond, Esri cofounder and president, draws on his 60 years of research and experience in the industry to argue that GIS and the geographic approach are critical to tackling the biggest challenges of our time—climate, biodiversity, poverty, health, and social justice—on scales from local to global. It features the work of the GIS community, whose members have advanced the application of the geographic approach through GIS technology to envision and build a brighter future.

This lavishly illustrated book contains 490 GIS maps packed into its 300 pages. More than 90 percent of these maps contain information layers from multiple GIS organizations. They show the ways that geographic science is transforming how people do their work. With a foreword by James Fallows, best-selling author and writer for *The Atlantic,* stories from GIS users demonstrate how the geographic approach can be used to better understand Earth. Esri Press, July 2024, 300 pp.; print ISBN: 9781589486065 and ebook ISBN: 9781589486072.

Bookshelf

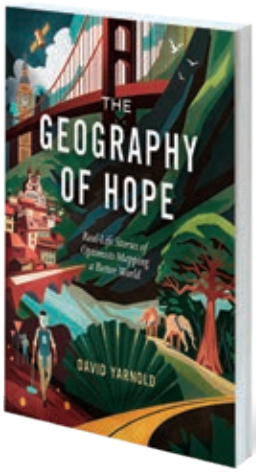
Mapping the Deep: Innovation, Exploration, and the Dive of a Lifetime

By Dawn J. Wright with Esri Press

The author, Dawn J. Wright, made history in 2022 when she became the first Black person to visit Challenger Deep, the deepest and least-explored place on Earth. *Mapping the Deep: Innovation, Exploration, and the Dive of a Lifetime* focuses on Wright's historic dive, personal journey, and the cutting-edge technology that made the expedition possible. Wright, chief scientist of Esri, is a specialist in marine geology, geography, and oceanography. This book, with a foreword by oceanographer and former astronaut Kathryn Sullivan, highlights the crucial importance of mapping the ocean and its profound impact on our future. September 2024, 190 pp.; print ISBN: 9781589487888 and ebook ISBN: 9781589487895.

The Geography of Hope: Real-Life Stories of Optimists Mapping a Better World

By David Yarnold



Through nine stories of people across the world who are using GIS to help communities and organizations prosper, *The Geography of Hope: Real-Life Stories of Optimists Mapping a Better World* puts human faces to GIS mapping and technology. These stories highlight the application of GIS to solve problems in health care, law enforcement, equity, conservation, national defense, and business profitability. The author, former National Audubon Society CEO and award-winning writer and photographer David Yarnold, traveled the world to introduce readers to the people who are effecting substantial change. October 2024, 246 pp.; print ISBN: 9781589487413 and ebook ISBN: 9781589487420.

The Locators: Adventure in Oceania

By Kyle Bauer, Colleen Conner, Wesley Jones

The Locators: Adventure in Oceania chronicles the latest adventures of the Locators—Lucy, Oliver, and Moe the Parrot—as they solve real-world problems using maps and spatial thinking to complete their missions. This book is the second in the series that began with *The Locators: Adventure in South America*. Readers help the Locators by completing the illustrated activities—such as puzzles, word searches, and map-based activities—that accompany each chapter and encourage critical and spatial thinking and improve reading comprehension. These tales are perfect for children aged 8–11 who love geography and exploring the world. The book's authors, Kyle Bauer and Colleen Conner, and illustrator, Wesley Jones, are all Esri staff members. Esri Press, 2024, 132 pp.; print ISBN-10: 1589487567 and ebook ISBN-13: 978-1589487567.

For more information on all Esri Press publications, visit esri.com/esripress.

My Journey to GIS
and How You Can Follow My Path

By Leea Kelly

Based in Camden, New Jersey, Hopeworks is a blended nonprofit organization and tech business that trains and hires high school students in both Camden and neighboring Philadelphia, Pennsylvania. Its skills development program specializes in GIS and web development. Hopeworks helps students successfully secure high-quality employment in their communities through a combination of tech training and support services.

↑ Through the Hopeworks program, Leea Kelly began a fulfilling and rewarding GIS career.

← Kelly currently works as a GIS analyst for the Delaware Valley Regional Planning Commission (DVRPC).

Several years ago, I was searching for restaurant jobs online with no clear direction, when a friend recommended Hopeworks. This nonprofit social enterprise is dedicated to training young adults in the technology fields that will propel them into living-wage careers.

Before learning more about the Hopeworks program, I was skeptical that I would achieve success. I had always categorized myself as an artistic person and had no inkling of my potential in tech. However, after learning more about how the organization prepares young adults for the working world, I felt as though the door to excelling in the industry had swung open. Hopeworks offers trauma-informed support, real-world experience, and comprehensive technical training.

During the training modules at Hopeworks, I was introduced to the intricacies of GIS. To my surprise, what began as a detour from my usual job search turned into a fascination with the capabilities of GIS. However, this transition did not occur immediately. Even after learning about Hopeworks and being invited into the program, I thought my background in art would lead me to the web design team, but GIS took hold instead.

The training process at Hopeworks was both challenging and rewarding. Entering this endeavor with no prior knowledge meant I initially struggled to grasp the technical aspects of GIS. However, with the guidance of dedicated mentors and the support of my peers in the training room, I gradually navigated the complexities of GIS. Some tasks, such as extensive data entry or spreadsheet training, felt tedious, but I was determined to gain a deeper understanding of GIS. Eventually, I looked for additional training opportunities to enhance my skills.

I started to apply my newfound skills in the real world. While working on a project with the Pineland Preservation Alliance, I fell in love with GIS. The project aimed to create outdoor recreational areas in New Jersey where regions with underserved demographics and unused parkland overlapped. Making a tangible impact in my own backyard spurred me to dive headfirst into GIS and the tech industry as a whole.

Starting my career in GIS at Hopeworks has made all the difference in my professional journey. The organization not only opened the door to the industry but also helped me understand its profound impact on communities. For example, in my current position as a traffic data analyst, I utilize GIS to analyze transportation data, such as origin surveys and demographic information from riders. This work allows Hopeworks and its partners to make informed decisions about infrastructure improvements.

Outside of work, I now see GIS everywhere I go—literally. I've taken the Southeastern Pennsylvania Transportation Authority (SEPTA) for my entire life. I use the bus tracker religiously. People often don't give much thought to the inner workings of their local transit app, but the

GIS technology used by these apps allows accurate, real-time updates, which is essential for getting the most out of public transit. GIS often goes unnoticed but offers endless career opportunities, especially with programs like Hopeworks to guide aspiring professionals.

Once I knew GIS was the path for me, I had to tackle the challenge of breaking into the field by finding a job. Luckily for me, Hopeworks not only offered training and experience with tactical skills, but also helped me develop soft skills like understanding the (often unspoken) intricacies of the job hunt process that can range from choosing an interview outfit to signing an offer letter.

Initially I was actually looking for a different position. However, Fred Harris, my coach at Hopeworks, gave me the confidence to also apply for a GIS-related position. I was certain that due to my background, the hiring manager for the GIS-related position wouldn't even glance at my résumé.

Yet here I am—two years later—celebrating a promotion at my current company, Delaware Valley Regional Planning Commission (DVRPC). Anything worth doing is going to be a little uncomfortable at first, but enhancing your soft skills can give you the confidence needed to succeed.

How Young Adults Can Break into GIS

What is my number one tip for finding a job in GIS? Don't count anyone out—including yourself! Broadening your horizons and accepting that you may have untapped skills beneath the surface is the first step in changing your career trajectory.

Young adults like me, who historically do not have an interest in technology, often find this industry intimidating. However, with the right approach and resources, the path becomes clearer and the possibilities more tangible. All you need to do is take that first step. Feeling unsure when exploring a new field is completely normal. It is even expected.

Young adults need to give themselves room to make mistakes and experience frustration. Once you can accept that you will make errors—and that's OK—embracing the learning process becomes infinitely easier. That is half the battle.

I thought a career in tech would never be in the cards for me, but now I work full-time with GIS. I am a firm believer that with the right team and tools, anyone can conquer previously self-imposed barriers. Getting out of your own way is the hardest part! With determination, guidance, and a willingness to step out of their comfort zone, young adults can unlock the doors to a thriving career in GIS and make meaningful contributions to their communities and beyond.

For more information, contact Gillian Scott at Gillian@redthreadpr.com.

About the Author

Leea Kelly is a Hopeworks GIS team alum and currently works as a traffic data analyst for the Delaware Valley Regional Planning Commission (DVRPC). She prides herself on possessing the spatial intelligence and pattern recognition skills that are required to thrive in GIS. Outside of work, she applies her knowledge to three-dimensional artistic pursuits that include silversmithing and crochet.

Modern Hybrid GIS Deployment Benefits Boston College

By Monica Pratt

Since taking the position of GIS/lifecycle data analyst at Boston College in 2021, Kevin Hess has made substantial improvements to the accuracy, security, and value of the institution's spatial data. By adopting a hybrid solution that shares public data via ArcGIS Online and manages sensitive facilities data securely and efficiently in ArcGIS Enterprise, Hess implemented a modern GIS for Boston College.

A private research university with a current enrollment of more than 15,000 students, Boston College was founded in 1863 by the Society of Jesus (Jesuits) in Boston's South End as a liberal arts college. The main campus is now located in nearby Chestnut Hill, with additional campuses in Brighton, Newton, and Brookline.

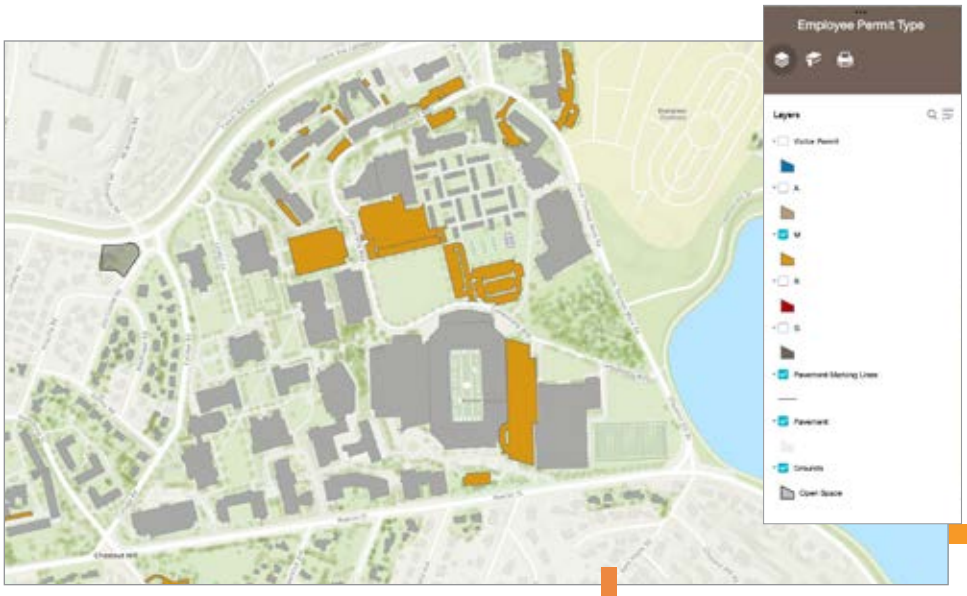
More Efficient and Accurate

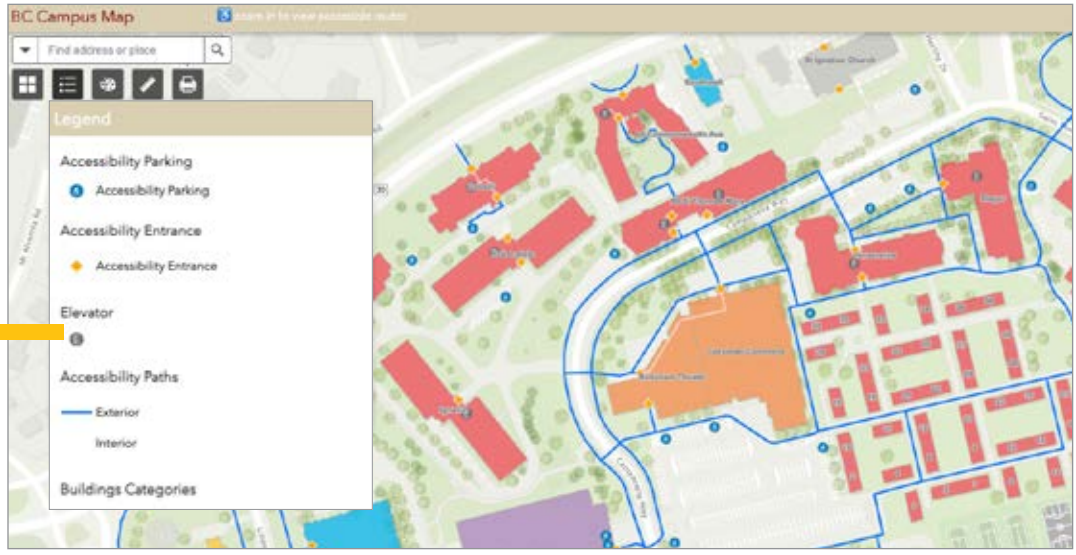
Boston College has been using GIS since 2008. Prior to Hess's arrival, all GIS work had been completed using ArcMap. Maps were made available through ArcGIS Online and ArcReader. All GIS data was stored in a geodatabase on a file server.

"Since starting in my position, my first initiative was to migrate all maps and projects into ArcGIS Pro. I found *[ArcGIS]* Pro to be much

more efficient and reliable, and generally provided better functionality to my work," said Hess.

Although most of the campus had been mapped, data had been imported from sources such as Adobe Illustrator and AutoCAD. As a result, spatial accuracy for the entire campus map was lacking. The accuracy problems Hess identified included building footprints that were shifted and sized incorrectly and surface features, such as roads and sidewalks, that had been roughly digitized. Underground utility data was shifted and updates for major projects were missing.





↑ Permit and visitor parking maps can be filtered by type of parking.

← The accessibility map shows parking, walkways, entrances, and elevators. Hess worked with others on campus to correct and update features.

←← Gasson Hall, built in the English Collegiate Gothic style, is named in honor of former president Rev. Thomas I. Gasson, SJ.

Consequently, improving spatial accuracy of the entire GIS was a top priority. "I spent a very significant amount of time and effort editing all features to effectively redigitize the entire campus using surveys where available and high-resolution imagery elsewhere," Hess remembered.

Redigitizing and correcting the spatial accuracy of surface features consumed his first six months at Boston College. However, Hess has continued improving accuracy, using new surveys as they are conducted and collecting GPS data on campus using a Leica GPS/GNSS device. To maintain and continually improve data accuracy, he works with all project managers to ensure he receives quality as-built drawings and surveys for any work done on campus.

Hess has moved on to more complex datasets, such as those associated with campus utilities. Acquiring location information for these assets has been more challenging. For all new utilities, he captures GPS coordinates during installation so that precise horizontal and vertical location data is obtained.

Enhancing Existing Maps

Although the accessibility map showing parking, walkways, entrances, and elevators existed previously, Hess worked with others on campus to update features and make corrections to accessibility paths. Maps that provided information on permit and visitor parking were also outdated, so he made them current and implemented functionality to easily filter parking spaces by permit type. All these public-facing maps were updated in an ArcGIS Experience Builder app that is integrated with the Boston College website, making them easy to locate while maintaining institutional branding as well as improving map printing.

Improving Data Management and Security

After migrating the maps and projects to ArcGIS Pro and improving data spatial accuracy, Hess wanted to implement ArcGIS Enterprise because it addressed several concerns he had about the GIS implementation he inherited.

"My most recent initiative has been to improve the security, management, and availability of the GIS data. This was the driving factor for deploying ArcGIS Enterprise," said Hess.

Previously, the data resided in a file geodatabase on a network share. "While we restricted who had access, I was always concerned about data links being broken, the quality of backup processes, and lack of editing control," said Hess.

By moving to ArcGIS Enterprise, he was able to store sensitive utility data and better control management of that data. Hess moved all GIS data to a Microsoft SQL Server Enterprise geodatabase. This data included data for the college's steam, gas, telecom, electricial system, stormwater, sewer, irrigation, and chilled water. Boston College has moved away from maintaining utility data in CAD. It uses GIS to store and maintain the information. However, Hess has processes that export utility features maintained in GIS to CAD so it can be shared in that format, if needed.

Moving to ArcGIS Enterprise improved read/write speeds when editing and viewing data, which optimized workflows. Now he could store sensitive utility information and distribute it through Portal for ArcGIS, rather than ArcGIS Online. With Portal came better authentication and control over who could access and edit data. By enabling versioned workflows, student workers could edit their own versions instead of working directly with production data. The move to ArcGIS Enterprise allowed the use of better processes for data backups.

Migrating to ArcGIS Enterprise also streamlined operations. Hess has published a web app that references the utility data directly from the SQL database. This map updates on the fly, so everyone sees the most current data without requiring Hess to update ArcGIS Online layers. He plans to publish more apps and maps with referenced data.

Hess characterizes the organization's response to the move to ArcGIS Enterprise as "excellent." Once ArcGIS Enterprise was set up, he could generate all the user accounts needed without having to get users to set up accounts or remember passwords to access maps.

Expanding GIS

Just as Boston College is constantly evolving, so is its GIS. Two large property acquisitions have required updates for the accessibility and parking maps. Hess is also considering building a 3D campus map of Boston College. This map could be shared publicly and used as a tool for planning initiatives on campus. It would be useful for visualizing lines of sight and previewing how proposed projects would look on campus.

About the Author

Monica Pratt is the founding and current editor of *ArcUser* magazine, the executive editor of *ArcNews* magazine, the editor of *Esri Globe*, and head of the Publications team at Esri. She has been writing on technology topics, specializing in GIS, for more than 28 years. Before joining Esri in 1997, she worked for newspapers and in the financial industry.

BUILDING A CAREER ON A STRONG FOUNDATION

Although Kevin Hess is the sole GIS professional in the Facilities Management Information Systems Division, he creates maps and visualizations for other departments at Boston College including the communications, parking and transportation, and athletics departments, and the Office for Institutional Diversity. His previous employment and formal education prepared him with the skills and knowledge required for his current position administering Boston College's GIS.

Before coming to Boston College, Hess worked as a GIS analyst for Union County, Pennsylvania, where he was a member of a small team. At the county, he edited data: parcel fabrics, road centerlines, addresses, and other local government features. His team also maintained the GIS for neighboring Snyder County. While the two-county area was larger, the GIS for Boston College's campuses requires a higher level of detail, although much of the work is fairly similar. While with Union County, he worked directly with the public. In his current position, he interacts primarily with members of the Boston College community.

Hess obtained a bachelor's degree in geoenvironmental science with a minor in GIS from Shippensburg University in Pennsylvania. His university coursework provided Hess with a strong foundation for his work at Boston College. His academic studies relating to his minor concentrated on GIS, geography, and remote sensing. He cites one of his professors at Shippensburg University, Dr. Scott Drzyzga, as instrumental in helping him gain a deep conceptual understanding of geospatial fundamentals and to think spatially.

"This not only inspired me and heavily guided my career path but also prepared me for my current position. While I have had learn *[ArcGIS]* Enterprise administration, I wouldn't be where I am today without my degree work," said Hess.

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TRACKING DINOSAURS TODAY

By Kimberly Hartley

It isn't rare for Tom Hebert to pick up his phone and hear: "I found a dinosaur. Can you come dig it up?"

Through partnerships with technology companies, Hebert is using RFID tags and GIS mapping to track and document dinosaur fossils with the goal of creating a shared map displaying discoveries worldwide. *[RFID (radio-frequency identification) tags use radio frequencies to transfer data that uniquely identifies an object, person, or animal and can be used to track its location.]*

From his home in Wisconsin, Hebert has spent 14 years driving to and from the dinosaur fossil-filled ranges in South Dakota, North Dakota, Montana, and Wyoming for digs. Lately, he has also been visiting museums to create a digital record of fossils on display or in storage. His goal is to transform the way museums manage fossils and other assets, using digital tools that include ArcGIS Survey123, a location-aware data collection app, and InfraMarker, an RFID tracking technology.

Often only a fraction of a museum's collection is on display at any given time. Most of the collection is stored behind the scenes on shelves, in drawers, and sometimes in off-site warehouses. The work of collecting, identifying, and displaying artifacts has long relied on handwritten notes and printed records. Keeping track of artifacts is challenging, even for the largest museums. It's no wonder, then, that audits have revealed pieces that have gone missing or have been damaged or stolen.

Researchers at the Smithsonian Institution and the National Science Foundation, which funds the Integrated Digitized Biocollections site, see value in digitizing records of collections. Such records would make it easier to answer critical questions about our Earth, including how the estimated 22 percent of remaining species recovered from the mass extinction event 66 million years ago that annihilated the remaining dinosaurs.

By attaching RFID tags to fossils, Hebert can track specimens from dig sites to warehouse shelves, to where they are cleaned and prepared and placed on display. This new awareness of fossil location—including near real-time tracking while in transit—provides a map-based audit trail that Hebert likes to call "dig to display." It's the first step in what he hopes could become

a single shared map showing where many of the world's dinosaur bones have been found and where they are now. Hebert also thinks the RFID technology paired with a map could be a tool for federal regulators to monitor the excavation permits they issue on some of the millions of acres of land they oversee.

It's a continuation of Hebert's mission to make dinosaur excavating accessible to more people of all ages, especially military veterans and children, whom he invites to join his digs on private property.

"Dinosaurs are how we get kids into science," he said. His youngest daughter is the reason he started digging. She wanted to go on a fossil hunt, so Hebert found a group that offered trips in South Dakota. That is where he fell in love with the activity. His daughter is now studying to be a marine biologist.

From Insurance to Fossils

Before Hebert began venturing to rocky landscapes each summer to dig for fossils, he owned an insurance agency. He used GIS to find out about the locations he was insuring.

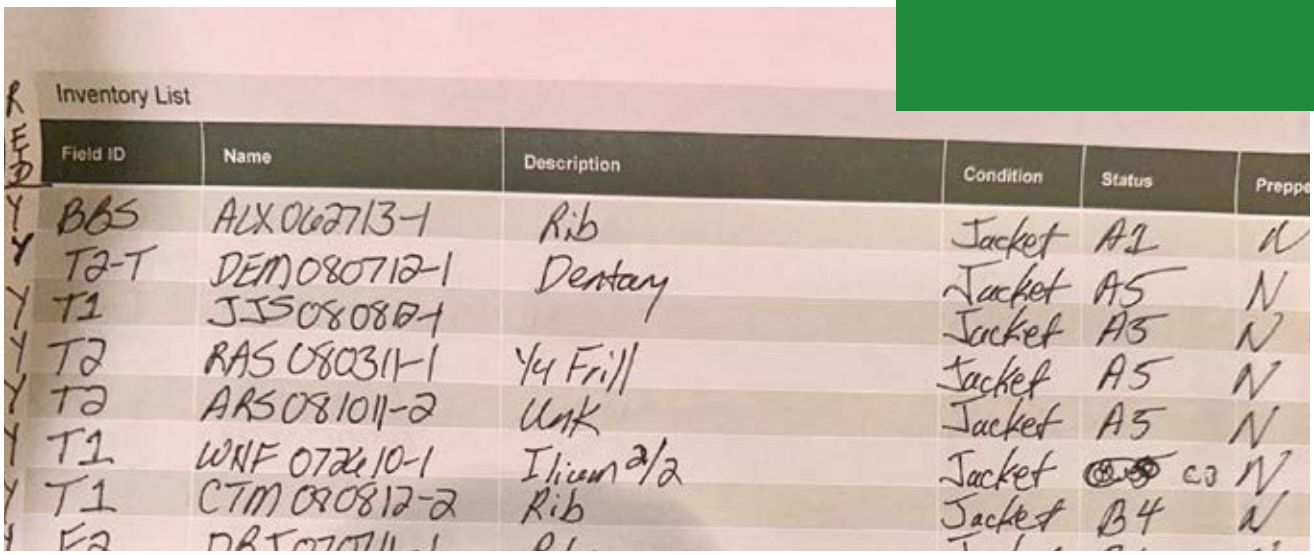
When he returned to school in fall 2020, he had an aha moment sitting in a GIS class at the University of Wisconsin–Eau Claire.

"Wait a minute, why can't we do this with dinosaur bones as we're digging them up?" he thought.

That simple question turned into a research project and a request to borrow tens of thousands of dollars' worth of the geography department's mapping equipment. When the department said no, Hebert partnered with companies that were willing to lend him their technology. One company was Esri partner Carlson Software.

↓ Collecting, identifying, and displaying artifacts has long relied on handwritten notes entered in traditional inventory tracking sheets. (Photo courtesy of InfraMarker)

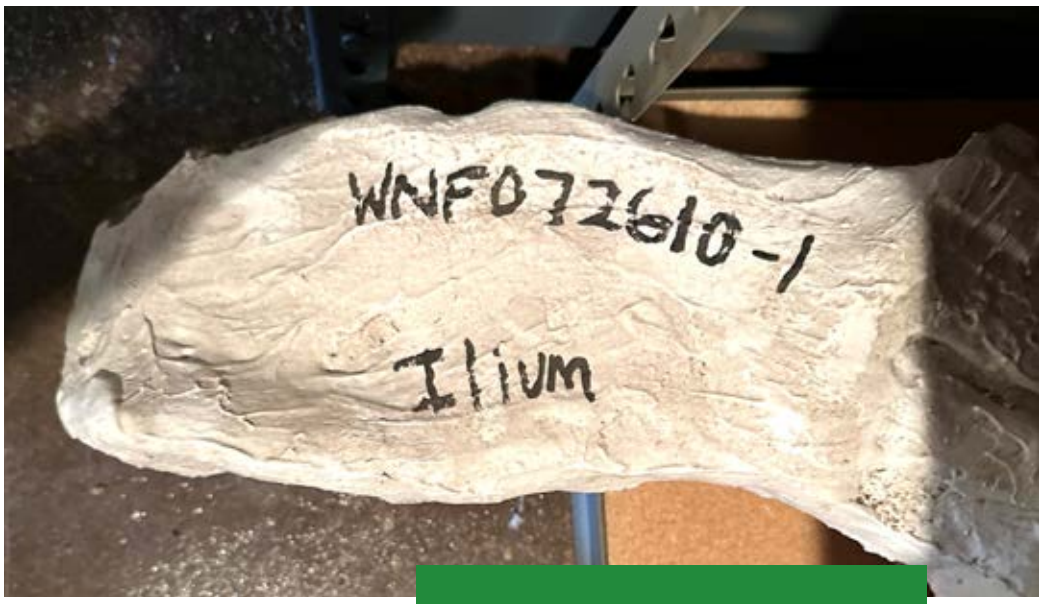
↓↓ Most of any collection is often stored on shelves, in drawers, and in warehouses so objects and the data about them can be difficult to access. (Photo courtesy of InfraMarker)



The company's field software and hardware are typically used for land surveying, civil engineering, construction, and mining.

Hebert reached out to Ladd Nelson, the company's Midwest sales director. Nelson, who was fascinated by dinosaurs while growing up, said that the proposal captured his inner child. When Hebert explained what he wanted to do, Nelson was confident that Carlson had the equipment that could help him.

"We've tried to show people that Carlson can do much more than surveying and engineering," Nelson said. "The word is getting out there that we can help organizations get all their geographic databases online and populated with highly accurate location information to ensure they not only know where their assets are now but can more easily find them again in the future."



↑ The traditional identification method uses a field number marked on the fossil. That number must be deciphered and matched to inventory records. (Photo courtesy of InfraMarker)

← An RFID reader, connected to a ruggedized iPad loaded with InfraMarker RFID technology and ArcGIS Survey123, is used to record data about fossil bones as they are unearthed. (Photo courtesy of InfraMarker)

Or, in the case of dinosaur fossils, where they were first uncovered before being moved to storage or museums.

Recording Fossils on the Standing Rock Indian Reservation

Hebert crossed paths with Esri partner Berntsen, the maker of the InfraMarker RFID tagging technology, in the exhibit hall at the Trimble Dimensions conference in 2022. This encounter led Hebert to test Berntsen's InfraMarker RFID solution during digs in 2023 on the Standing Rock Indian Reservation, which encompasses more than 3,500 square miles and straddles the border between North Dakota and South Dakota.

"It's all solving the same problem: how do you connect assets to a map?" said Mike Klonsinksi, president of Berntsen. Whether it's an underground pipe or a dinosaur bone, in GIS, it's an asset with a location.

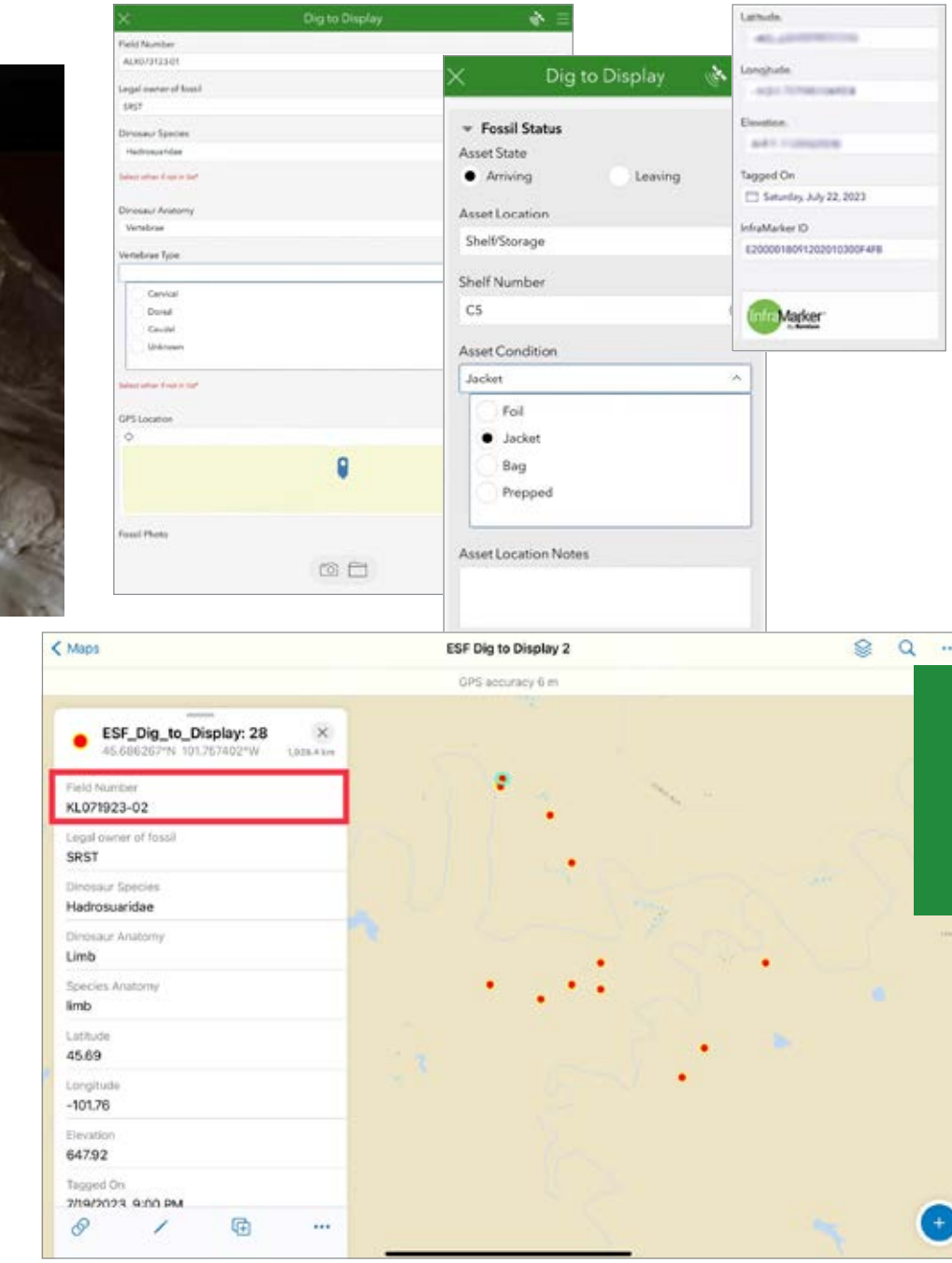
Museum archivists and curators are generally reticent about physically handling their valuable specimens and pieces for fear of damage. RFID scanning can be done from a distance to inventory a collection. If someone on staff can't find an item where it's supposed to be, larger areas can be scanned to detect it. In addition, RFID antennas can be positioned in areas where artifacts are regularly moved from storage to display or vice versa to track where each item is at any given time.

"For us, the biggest lesson here is, it's not a dinosaur solution, it's really an asset-to-GIS solution," Klonsinski said.

For the Standing Rock Sioux Tribe, Hebert's efforts have offered a way to better record information about the more than 10,000 existing fossils the tribe's leaders will need to relocate to a temporary storage facility. "We need to secure the fossils we have," said Fawn Wasin Zi, the tribe's outgoing director of reservation resources. In Hebert, the tribe members found a paleontological partner willing to donate his time to protect their fossils, Wasin Zi said.

Hebert and his team found and tagged about 50 new fossils in the field and created digital records for several hundred more in the tribe's existing collection.

He is in the second year of a five-year agreement with the tribe that will be allow him to excavate fossils on the tribe's land after permits are sought and secured from the Bureau of Indian Affairs. Any fossils found are named and kept by the tribe.



↑ The Dig to Display workflow captures details about origin and other context that can be queried and mapped. (Photo courtesy of InfraMarker)

← The map of fossils recovered in this area helps researchers piece together the ecosystem that supported the diversity of species long ago. (Photo courtesy of InfraMarker)

Hebert's goal is to eventually help create an exhibit for a cultural museum that will be built on the tribe's land.

At the Museum of Discovery at Sheridan College in Wyoming, Hebert and the museum's directors spent five days in January 2024 cataloging about 700 fossils. Using ArcGIS Survey123 and ArcGIS Field Maps, they manually entered handwritten GPS coordinates that recorded where each specimen was found and attached an RFID tag to each one. Now a digital record will show if that fossil is on a shelf, on display, on a researcher's desk, or loaned to another museum.

Hebert is also adding contextual metadata to each fossil, including images, chemical information to determine the age, research paper links, and other resources. Determined to digitize the information that's normally been handwritten on index cards and stored in museum cabinets, Hebert wants to make the data and fossils easier to access.

"Cards get lost, cards get damaged, and reading handwriting is often impossible," he said. Stored in the cloud and pinpointed on a map, digital records promise to reveal more about the Triassic, Jurassic, and Cretaceous periods, when dinosaurs roamed the land. Dusting off records and bones and digitizing them to relate their origins could safeguard essential data about where dinosaurs lived and died, helping lead to better understanding about Earth's origins and changes over time.

About the Author

Kimberly Hartley is a senior content marketing strategist. Prior to coming to Esri, she was a journalist for 15 years, working as a reporter for *The Virginian-Pilot* in Virginia and the Associated Press in Las Vegas. Under the byline Kimberly Pierceall, she worked at *The Orange County Register* and *The Press-Enterprise*.

INSPIRING EXCITEMENT ABOUT EARTH SCIENCES

When Thomas Hebert decided to go from selling insurance to digging for fossils full-time, he wasn't interested in starting a for-profit business to organize excavation trips. There were already plenty of those, he said. He started his nonprofit, Earth Sciences Foundation (ESF), in 2021 to broaden access to fossil digs.

"I love the excitement of other people who discover something as they're digging. It's infectious," he said. "My goal is to try and keep it as affordable and accessible as possible."

The foundation offers free trips—so long as funding is available—to children 16 years old and younger and to veterans. He sees dinosaur fossil excavation as a magnet for getting more people, especially children, interested in earth sciences in general. For adults who aren't veterans, Hebert said his foundation charges $100 per day to dig, which he said is less than what others typically charge.

The organization currently has five board members. Ladd Nelson, sales director for Esri partner Carlson Software, is the past chair and current treasurer. ESF also has several college interns and as many as 40 volunteers at any given time. They assist with the foundation's mission, helping build museums to house found fossils and catalog specimens with RFID and GIS technology.

Hebert said ESF can act in a consultant capacity, teaching museum staff how to dig and track specimens with RFID technology, or ESF can handle the entire process. For cataloging several hundred fossils for the Museum of Discovery at Sheridan College, Hebert was compensated for his travel and materials. He sees his work as innovating with technology to increase knowledge of ancient life on Earth.

He estimates that the foundation has had about 1,500 children and 450 adults join digs since 2021. He sees the impact the program is having.

In addition, he said he's made presentations to about 10,000 children at schools in the intervening years. His group has also made it a goal to take veterans on site excavations. Since 2021, two digs have included a total of 12 veterans. The foundation covers all costs including travel, lodging, and meals. This amounts to about $2,500 per veteran for the whole week.

Getting funding to cover more trips has been a challenge. Hebert points to many other veteran organizations with greater recognition and longevity than his relatively new program. Much of his funding so far has come from grants. Hebert and his wife contribute to any shortfall.

"We would love to do more," he said.

Hebert has felt the peace and serenity of a fossil dig site and thinks the act of careful, diligent digging might be therapeutic to task-driven individuals. Hebert said he first got the idea to invite veterans to dig sites when his father, a Vietnam veteran who fought with the 1st Cavalry Division of the US Army, joined him on a family dig. A few hours into the dig, his father had found something—a T-Rex tooth.

"I've never seen my father smile like that before," Hebert said.

For more information about Earth Sciences Foundation Inc., including how to make a tax-deductible donation, visit letsdig.org/donate.

↑ Thomas Hebert founded the nonprofit Earth Sciences Foundation (ESF) to get people of all ages interested in earth sciences.

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